Printed on Thin Paper for Foreign Circulation.

The Engineer.

Established 1856.

Registered as a Newspaper

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXXXIII.—No. 3452] LONDON: FRIDAY EVENING, FEBRUARY 24, 1922 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

The Engineer

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A French Forced Draught Furnace.

A New Band Saw Guide.

PUBLIC NOTICES

British Standardised Steel SAMPLES.

Issued jointly by
THE IRON AND STEEL INSTITUTE
AND THE
NATIONAL PHYSICAL LABORATORY.

These samples are now available, together with certificate of standardisation, at the price of 21s. per bottle, containing 50 grammes. They may be obtained post free by sending order with remittance, direct from

THE NATIONAL PHYSICAL LABORATORY (Metallurgy Dept., Teddington, Middlesex;

or by post or personal application from

The Secretary, NORTH MIDLANDS DISTRICT AUTHORITY, Dept. of Applied Science, The University, Sheffield.

Depots in other centres are being arranged.

The Standards at present available are:—

No. 5 Carbon (C = 0.65 per cent.) Acid O.H. Steel.
No. 6 Carbon (C = 0.10 per cent.) Basic O.H. Steel.
No. 1 Sulphur (S = 0.027 per cent.).

Others are in preparation and will be issued when ready. 7048

Belfast Harbour.

The Belfast Harbour Commissioners are prepared to receive TENDERS for the CONSTRUCTION of a DRAINAGE CULVERT and MANHOLES, &c. (total length about 1450ft.), in the neighbourhood of the Hamilton-road, all in accordance with drawings, which may be seen at the office of the Harbour Engineer, Mr. T. S. Gilbert, M. Inst. C.E., from whom copies of the conditions of contract, specification, and form of Tender may be obtained.

Tenders must be made on the form provided for the purpose, and must be enclosed in a sealed envelope, endorsed "Tender for Drainage Culvert," and addressed to the undersigned and delivered not later than Monday, the 27th March, 1922.

The Commissioners do not bind themselves to accept the lowest or any Tender.

D. J. OWEN,
General Manager and Secretary.

Harbour Office, Belfast,
17th February, 1922. 7475

Bengal-Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for either or both of the following:—

(I).
5 DECK SPAN GIRDER BRIDGES, 100ft. span complete.
14 DECK SPAN GIRDER BRIDGES, 100ft. span complete.

(II).
5 DECK SPAN GIRDER BRIDGES, 60ft. span complete.
2 DECK SPAN GIRDER BRIDGES, 40ft. span complete.

Specifications and forms of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after 20th February, 1922.

For each specification a fee of £1 1s. will be charged, which will not be returned.

Tenders to be submitted not later than Noon on Monday, 6th March, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
R. C. VOLKERS,
For Managing Director.

7474

City of Leicester.

STEAM BOILERS, &c., FOR ABBEY SEWAGE PUMPING STATION.

The Sewage Works and Farms Committee invite TENDERS for:—

(1) LANCASHIRE BOILERS.
(2) MECHANICAL STOKERS and COAL CONVEYING PLANT.
(3) SETTING of the BOILERS.

Forms of Tender, &c., may be obtained at my office on payment of the sum of £2, which will be returned on the receipt of a bona fide Tender. Cheques, &c., to be made payable to the Corporation of Leicester.

Applications should state section desired.

Sealed Tenders, on the forms supplied, addressed to the "Chairman of the Sewage Works and Farms Committee, Town Hall, Leicester," must be delivered not later than 20th March, 1922, and endorsed "Tender for Boilers, &c."

The Committee do not bind themselves to accept the lowest or any Tender.

E. GEORGE MAWBEY, M. Inst. C.E.,
City Engineer and Surveyor.

Town Hall, Leicester,
21st February, 1922. 7505

Great Northern Railway (Ireland).

PERMANENT WAY MATERIALS.

The Directors are prepared to receive TENDERS for the SUPPLY of:—

BULL-HEAD RAILS,
FLAT-BOTTOM RAILS, and
FISH-PLATES,
of the British Standard Sections; also
CAST IRON CHAIRS and
PERMANENT WAY FASTENINGS.

Specifications, drawings, and forms of Tender can be obtained from the Secretary.

Tenders, made out on forms supplied by the Company, should be delivered, under sealed cover, endorsed "Tender for Rails, &c.," not later than 10 a.m. on Monday, March 20th, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

J. B. STEPHENS,
Secretary.

Amiens-street Station, Dublin,
17th February, 1922. 7482

The National Foremen's Association of the ENGINEERING AND ALLIED TRADES.

(Registered under the Trade Union Act.)

An Association specifically formed to look after the interests of Foremen in their Supervisory Capacity. All communications to Head Offices.

H. W. REID, 95, Belgrave-road,
General Secretary, Victoria, S.W. 1.

PUBLIC NOTICES

City of Carlisle.

The Corporation invite OFFERS for:—

ONE D.C. TURBO-GENERATOR SET, consisting of Mixed-pressure Turbine, by Willans and Robinson, direct coupled to Siemens 360 K.W. 460/550-volt Compound Wound Dynamo, speed 2700 r.p.m.; Surface Condenser with Augmenter, by Willans and Robinson, complete with Motor-driven Edwards Air Pump and Circulating Pump.

This plant is in good condition and could be usefully employed in increasing the efficiency and output of an existing installation of reciprocating steam plant.

The above plant can be seen by arrangement and further particulars obtained on application to the undersigned.

C. W. SALT, M.I.E.E.

Electricity Dept.,
Victoria Viaduct, Carlisle. 7506

Metropolitan Water Board.

TENDERS FOR THE SUPPLY AND FIXING OF A LANCASHIRE BOILER, SUPERHEATER, PIPING AND FEED PUMPS AT WEST WICKHAM, KENT.

The Metropolitan Water Board invite TENDERS for the SUPPLY and FIXING of ONE LANCASHIRE BOILER, SUPERHEATER, PIPING, FEED PUMPS, &c., at their West Wickham Pumping Station, Kent.

Forms of Tender, conditions of contract, specification, and drawing may be inspected without payment of fee at the Offices of the Board, Chief Engineer's Department, Room 182, New River Head, 173, Rosebery-avenue, Clerkenwell, E.C. 1, on and after Thursday, February 23rd, 1922.

Contractors desirous of tendering may obtain the necessary documents from Mr. Henry E. Stilgoe, M. Inst. C.E., the Chief Engineer, on production of an official receipt for the sum of £1 1s., which sum must be deposited with the Board's Accountant, and will be returned on receipt of a bona fide Tender, together with all incidental papers. Such payments and applications must be made between the hours of 10 a.m. and 4.30 p.m., Thursdays excepted (Saturdays, 10 a.m. and 12 Noon).

Tenders, enclosed in sealed envelopes, addressed to "The Clerk of the Board, Metropolitan Water Board, 173, Rosebery-avenue, E.C. 1," and endorsed "Tender for Boiler, West Wickham," must be delivered at the Offices of the Board not later than 10 a.m. on Wednesday, March 22nd, 1922.

W. MOON,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
16th February, 1922. 7501

Newton Abbot Rural District Council.

ILSINGTON WATER SUPPLY.

TENDERS are INVITED for SUPPLYING, DELIVERING, and LAYING about 2 MILES of 3in. CAST IRON WATER MAINS, together with requisite FITTINGS and WORKS in connection with the above undertaking.

Drawings may be seen and copies of specifications, bills of quantities, and forms of Tender obtained at my office on payment of the sum of £2 2s., which will be returned upon receipt of a bona fide Tender and the return of all the documents.

Sealed Tenders, endorsed "Ilsington Water Supply," to be delivered at my office not later than Ten o'clock on Tuesday, 7th March.

The lowest or any Tender not necessarily accepted.

By Order,
F. HORNER,
Clerk to the Council.

Council Offices,
64, East-street, Newton Abbot,
16th February, 1922. 7471

PUBLIC NOTICES

Havant Urban District Council.

MAIN SEWERAGE AND SEWAGE DISPOSAL WORKS EXTENSION.
UNEMPLOYMENT RELIEF WORKS.
GENERAL CONTRACT NO. 1.

The above Council invite TENDERS from responsible Sewerage Contractors for these WORKS, which comprise several Miles of Stoneware and Cast Iron Sewers, with Manholes, Flushing Tanks, Ventilating Columns, &c., for draining the areas known as Denvilles, Lymbourn and Langstone, and the Modification and Extension of the existing Sewage Disposal Works, including 5ft. diameter Tank Sewer, New Detritus Pits and Screening Chambers and Pump Well, New Engines and Pumps, Addition to existing Engine-house, New Engine-house at Langstone, Additions and Alterations to Sedimentation Tanks, New Percolating Filters, Humus Tanks, Storm Tanks, Sludge Beds, and other incidental work.

The contract will be let on the basis of a fixed profit and fixed sums for administrative and establishment charges, and for the supply and use and waste of all plant.

The contractor whose Tender is accepted will be required to find two sureties to the satisfaction of the Council, to join him in a bond for the sum of £3500 for the due performance of the work, and to employ to the fullest extent local unemployed.

Plans may be seen and a copy of the specification, bills of quantities and form of Tender may be obtained from the Council's Consulting Engineer, Major T. J. Moss-Flower, of 28, Victoria-street, Westminster, and Carlton Chambers, Baldwin-street, Bristol, at his Bristol office, on and after March 1st, 1922, between the hours of 10 a.m. and 4 p.m., on payment of a deposit of £10 Bank of England note, which will be refunded provided a bona fide Tender be received and is not withdrawn before the sealing by the Council of one of the Tenders, and provided that any documents supplied be returned to the Engineer.

On production of a receipt for the deposit, persons tendering may inspect the plans at Havant on a day and at a time and place which will be communicated to them.

Sealed Tenders, endorsed "Tender for Havant Main Sewerage and Sewage Disposal Works Extension, General Contract No. 1," are to be delivered at my office not later than Twelve Noon on Tuesday, March 14th, 1922.

The lowest or any Tender not necessarily accepted.

By Order,
E. R. LONGCROFT,
Solicitor and Clerk to the Council.

Council Offices, Havant, Hants,
February 18th, 1922. 7488

Havant Urban District Council.

HAVANT MAIN DRAINAGE AND SEWAGE DISPOSAL EXTENSION WORKS.
CLERK OF WORKS.

The Council invite APPLICATIONS for the above APPOINTMENT. Candidates must be thoroughly experienced in the Construction of Modern Sewage Disposal and Drainage Works, and be able to efficiently discharge the duties required of Clerk of Works on work of this kind, and must be competent with the use of the level and theodolite, and be able to set out and measure up works and keep accounts, &c.

No others need apply.

The Clerk of Works will be required to act under the direction of Major T. J. Moss-Flower, the Council's Consulting Engineer, in conjunction with the Council's Surveyor, and to give his whole time and to be exclusively engaged on the work.

Salary £7 7s. per week. No out-of-pocket expenses will be paid. Time about 10 months, subject to approved service.

Applications, marked "Clerk of Works," stating any previous experience and enclosing copies of three recent testimonials, to be sent direct to the Engineer at his Bristol Office, Carlton Chambers, Baldwin-street, Bristol, so as to reach him not later than Noon on Saturday, the 4th day of March, 1922.

By Order,
E. R. LONGCROFT,
Solicitor and Clerk to the Council.

West-street, Havant,
20th February, 1922. 7489

PUBLIC NOTICES

Metropolitan Borough of Hammersmith.

ELECTRICITY DEPARTMENT.

The Borough Council invite QUOTATIONS for the SUPPLY, DELIVERY, and ERECTION of ONE 20-TON WEIGHBRIDGE at their Electricity Works.

Form of Quotation, with full particulars, may be obtained on application to Mr. G. G. Bell, Borough Electrical Engineer and Manager, Electricity Works, 85, Fulham Palace-road, Hammersmith, W. 6.

Quotations, endorsed "Quotation for Weighbridge," must be delivered to the Engineer and Manager not later than 4 p.m. on Friday, 3rd March, 1922.

The Council do not bind themselves to accept the lowest or any Quotation.

LESLIE GORDON,
Town Clerk.

Town Hall, Hammersmith, W. 6,
21st February, 1922. 7515

TO FIRMS WANTING CONTRACTS.

Quotations are Required for MANUFACTURE in batches of 250, on repetition lines, of lightly constructed Brass Hand-operated AIR PUMPS for low pressures, 2in. bore by 15in. stroke, with solid-drawn tubular barrel, single disc valve, and special two-way cock. The product is simple and easily made in any plain machine shop. Prices should be as if for a single lot of 250, although expected to be repeated from time to time.

The advertiser does not bind himself to accept the lowest or any quotation. Drawings of complete article, showing all production data, will be sent upon payment of fee of 12s. 6d., which will not be returned under any circumstances, to Mr. H. GEORGE HORLEY, Consulting and General Engineer, Grand avenue, Camberley. 7332

Tenders are Invited by the Government of New South Wales for the CONSTRUCTION of the SUPERSTRUCTURE and SUBSTRUCTURE of a CANTILEVER BRIDGE across Sydney Harbour from Dawes Point to Milson's Point, embracing a main span of 1600ft. in the clear, centre to centre of main piers, or 2600ft. centre to centre of anchor piers. The total length of bridge included in Tender is 3816ft., centre to centre of abutments. The deck of the bridge is to include four lines of railway, and a roadway 35ft. wide, between main trusses; and cantilevered outside the main trusses on the western side, a footway 15ft. wide, and on the eastern side a motor roadway 18ft. wide. Copies of specification, including plans, general conditions and schedule of quantities may be obtained on application to the undersigned.

To give any information required by tenderers, Mr J. J. C. Bradfield, Chief Engineer, will be in London during June and July, 1922, address care of the undersigned.

Tenders in accordance with the specification must reach the Under Secretary for Public Works, Sydney, not later than 31st October, 1922.

AGENT-GENERAL
FOR NEW SOUTH WALES.

Australia House, Strand, London, W.C. 2,
December, 1921. 7086

The Bengal and North-Western RAILWAY COMPANY, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of

4 SUPERHEATED 4-6-0 TYPE PASSENGER LOCOMOTIVES,

as per specification to be seen at the Company's offices.

Tenders, addressed to the undersigned and marked "Tender for Locomotives," are to be lodged not later than Noon on Monday, the 27th day of March, 1922.

For each specification a fee of £1 will be charged, which cannot under any circumstances be returned.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
E. A. NEVILLE,
Managing Director.

237, Gresham House, Old Broad-street,
London, E.C. 2,
21st February, 1922. 7524

The Bengal and North-Western RAILWAY COMPANY, LIMITED, AND THE ROHILKUND AND KUMAON RAILWAY COMPANY, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of:—

(a) 23½ TONS COPPER INGOTS, &c.,
(b) 30 TONS STRAND WIRE for FENCING,
(c) 40 TONS RED LEAD and 6 TONS WHITE LEAD,
(d) 296 PAIRS WHEELS and AXLES,

as per specifications to be seen at the Company's offices.

Tenders, addressed to the undersigned and marked "Tender for Copper Ingots, &c.," or as the case may be, are to be lodged not later than Noon on Monday, the 6th day of March, 1922.

For each specification a fee of 10s. will be charged, which cannot under any circumstances be returned.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
E. A. NEVILLE,
Managing Director.

237, Gresham House, Old Broad-street,
London, E.C. 2,
21st February, 1922. 7525

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PUBLIC NOTICES

Lambeth Borough Council

PARTICULARS and PRICES (including and fixing) of any SECOND-HAND IRONING or CALENDER MACHINES offered for sale, suitable for use in its uses, such offers to be enclosed in an d "Decoudun or Calender Machine," to "the undersigned not later than Noon on Friday, the 3rd March, 1922.

BRUCE PENNY,
Town Clerk.

Hall,
S.W. 2. 7531

Singapore—Straits Settlements.

CEMENT WORKS.—CHEMIST.

WANTED for a Cement Works recently completed in Singapore, a CHEMIST, with an intimate knowledge and experience in the Manufacture of Portland Cement by the wet process, and familiar with the conduct of analyses of fuel and flue gases and all the details pertaining to the duties of a Chemist in a modern cement factory. There are two rotary kilns 125ft., mills, Grimm, tube, electric drive. Only fully experienced men need apply.

Salary £900 to £1200, according to experience, with furnished house at the works, use of motor car and bonus; four years' agreement; excellent prospects for good man.

Applications, stating age, place of birth, and giving details of education, training, and experience generally, referring particularly to the above requirements, with dates, and accompanied by copies of not more than six testimonials, must be lodged with Messrs. C. C. LINDSAY and PEIRCE, 180, Hope street, Glasgow (who will supply further information if desired), not later than Tuesday, 28th February. 7445

SITUATIONS OPEN

WANTED, a YOUNG ENGINEER of Good Address and education, who has served his time in a machine tool maker's and has some general knowledge of engineering and wishes to enter the commercial side.

Must be willing to go abroad later. State age and salary required.
Address, P4904, The Engineer Office. P4904 A

WANTED, WORKS ENGINEER to Oil Installation at Avonmouth. Applicants must have good experience of W.T. Boilers, Duplex Oil Pumps, also Internal Combustion Engines on river vessels. Qualified sea-going engineer preferred, age 30-45. —Apply by letter only, with full particulars of experience and copies of testimonials, to BRITISH PETROLEUM CO., Ltd., Engineering Dept., 3, Throgmorton-avenue, London, E.C. 2. 7517 A

ENGINEER REQUIRED for Estimating and Negotiating Contracts and carrying these through to letion. Public school and university man preferred. Practical training and knowledge of design of surface Condensing Plants absolutely essential. Should be experienced and combatant salesman with good connection, whose chief duties would be to promote energetically the sale of machinery of this character.—Address, giving full particulars, with age and salary required, 7439, The Engineer Office. 7439 A

PLANER DRIVE, Described "Engineer," July 29th, 1921, and "Machinery," July 28th, 1921, and "Machinery Market, November 4th, 1921. LOCAL REPRESENTATIVES REQUIRED, with entree to engineering works. Only responsible men of standing should apply, describing connections, areas, and method of procedure.—NEWTON BROS. (Derby), Ltd., Derby. P4961 A

WORKS MANAGER REQUIRED for Works Near Sheffield, with practical knowledge of Press, Capstan, and Machine Work generally, also of Small Assembly Work. Applicants must have held similar position previously. It is essential that applicant should be a highly efficient organiser and have latest knowledge of modern methods of production. Full particulars, stating age, salary, &c., only considered.—Address, 7527, The Engineer Office. 7527 A

WANTED, DRAUGHTSMAN, Used to Designing and making working drawings of Seed Drills and Agricultural Machinery; could arrange for work to be done in spare time.—Address, P4973, The Engineer Office. P4973 A

CRANE DRAUGHTSMAN WANTED for Manchester district; knowledge of Structural Work an advantage.—Address, stating age, experience, and alary required, 7432, The Engineer Office. 7432 A

SHIPS' DRAUGHTSMAN WANTED, Having Long and wide experience in the Design of Small Craft, Paddle Boats, Stern-wheelers, Launches, Dispatch Boats, &c. Applicant would require to do his own drawings and calculations and should not be under 40 years of age. Give full details and state salary required.—Address, 7448, The Engineer Office. 7448 A

INDIA.—REQUIRED IMMEDIATELY, Experienced WAGON SHOP FOREMAN, unmarried; 5 years' engagement, free passage out and home. Good opportunity for thoroughly capable man.—Address, giving experience and copies of testimonials, 7534, The Engineer Office. 7534 A

WANTED for Bucks, LEADING HAND, First-rate FITTER and ERECTOR, used to High-class Engine Work; better if also a turner. State age, experience, and pay required.—Address, 7487, The Engineer Office. 7487 A

MOULDER, Conversant Locomotive Cylinder Castings, REQUIRED as FOREMAN in Iron-foundry Locomotive Builders; must be absolutely reliable. State age, experience, and wage.—Address, 7491, The Engineer Office. 7491 A

SMART YOUNG MAN REQUIRED in Estimating Department of Engineering Works. Essential to be able to accurately estimate weights of material. Knowledge of labour cost not essential.—Address, P4967, The Engineer Office. P4967 A

SITUATIONS WANTED

A.C.G.I., 2 Years Finsbury and 9 Months Shops, DESIRES START with civil engineer as Junior Assistant or Draughtsman. Only small remuneration expected. Not afraid of hard work.—Write, W., 9, Wilmot-place, N.W. 1. P4962 B

BUYING ENGINEER.—The MANAGER of a Large Engineering Works Purchasing Dept., who has an exceptionally wide knowledge of the markets of the country, DESIRES to NEGOTIATE NEW APPOINTMENT.—Write, Z, M, 613, c/o Deacon's, Leadenhall-street, E.C. 3. 7520 B

CIVIL ENGINEER, A.M.I.C.E. (31), Recent Experience commercial and transport conditions in Baltic States; many years public works with both contractors and engineers, German, French, Portuguese, DESIRES ENGAGEMENT.—Address, P4987, The Engineer Office. P4987 B

ENGINEER (28), A.F.R. Ae. S., 4 Years' Apprenticeship general engineering, gas and steam engines, seven years structural design, in charge of D.O., own correspondence, DESIRES POST, home or abroad, administrative or design.—Address, P4974, The Engineer Office. P4974 B

ENGINEER (35), A.M.I.M.E., M.I.A.E., &c., Many years' experience works and business management, and with complete commercial experience, including sales organisation, experienced designer and with extensive knowledge of works accountancy, shortly relinquishing managing directorship, SEEKS responsible Managerial APPOINTMENT. Would consider home, continental, or foreign representation. —Address, P4922, The Engineer Office. P4922 B

SITUATIONS WANTED (continued)

EUSTACE ARCHER, Civil Engineer, of 20 Years' standing (10 years in London), at present employed on important railway construction in Norway, SEEKS POSITION in Australia or New Zealand as Leading Engineer for location and construction of section or whole railway line. Excellent testimonials and college degree.—Reply, Box V. 95, National Advertising Service, St. Ann's Chambers, Ludgate-hill, E.C. 4. 7363 B

TO ENGINEERS, MANAGING DIRECTORS, AND MANUFACTURERS.

GENTLEMAN (45), M.I. Mech. E., A.M.I.E.E., SEEKS APPOINTMENT; 25 years' organising and administrative experience in electrical and mechanical engineering drawing-office, estimating cost and stores systems, methods of payment by results, works buildings, installation, equipment, planning and lay-out, power schemes and contracts. Has controlled successfully large works and staffs employing 1500-6000 hands for last twelve years. Excellent credentials. Will accept reasonable salary with prospects or entertain partnership. Replies will be treated confidentially.—Address, P4984, The Engineer Office. P4984 B

LOCOMOTIVE SUPT. or CHIEF MECHANICAL ENGINEER (36), late Major, R.E., Mem. American Soc. Mec. Engrs., OPEN for ENGAGEMENT at home, Colonies, or abroad. Thorough railway shop and running experience, English and American practice, accustomed use of fuel oil; several years employed Latin America; good organiser, tactful disciplinarian; fluent Spanish; good references; available interview.—Address, P4976, The Engineer Office. P4976 B

MECHANICAL ENGINEER (28), 12 Years' Experience in machine tool design and plant lay-out for locomotive, motor car, and electrical work, DESIRES SITUATION.—Address, P4971, The Engineer Office. P4971 B

ORGANISER of Proved Ability, M.I. Mech. E., DESIRES POST in advisory capacity. Wide commercial and manufacturing experience at home and abroad. Moderate salary and bonus according to results.—Address, P4952, The Engineer Office. P4952 B

SOUTH WALES AND SOUTH-WEST OF ENGLAND.—ADVERTISER with connection amongst architects, contractors, &c., SEEKS APPOINTMENT as Representative to first-class firm of Constructional Engineers and Ironfounders.—Address, P4965, The Engineer Office. P4965 B

TECHNICALLY TRAINED MARINE ENGINEER (27), 9 years shops, D.O., and an experience with firms of repute. Extra B.O.T. and college certificates, DESIRES POST as Assistant to Works Manager or Consulting Engineer.—Address, P4993, The Engineer Office. P4993 B

WORKS MANAGER REQUIRES POSITION. Wide experience all branches, tactful organiser, proved record; home or abroad.—Address, P4933, The Engineer Office. P4933 B

YOUTH (17) REQUIRES SIT. in Mech. Eng. Drawing-office; 3 yrs. workshop exp. and 2 yrs. tech. classes. S.W. London preferred.—Address, P4995, The Engineer Office. P4995 B

CAPABLE JUNIOR DRAUGHTSMAN REQUIRES POST. Five years' experience of large plant and structural work. Testimonials and diplomas. Small salary.—Address, P4977, The Engineer Office. P4977 B

DRAUGHTSMAN, 9 Years' Experience in Design and lay-out of plant, also steam and oil engine design. Diploma and certificates; excellent references. —"G.," 24, Courtney-road, Waddon, Surrey. P4981 B

DRAUGHTSMAN (22) SEEKS SITUATION; 7 yrs. D.O., sound tech. train., mech. and struct. eng., good experience in foundry.—Address, P4922, The Engineer Office. P4922 B

DRAUGHTSMAN (23) SEEKS POST in London. Sound technical training and excellent testimonials; energetic, practical, and adaptable.—Address, P4988, The Engineer Office. P4988 B

DRAUGHTSMAN (23), Ex-Service Man, Experienced in Colliery and general engineering, student International Correspondence Schools, secondary education, excellent references; willing to go abroad.—TOMPSON, Mayfield, Tamworth. P4975 B

L.C.S. STUDENT REQUIRES SITUATION as Junior Draughtsman; 4 years' experience.—1, Blunfield-street, Bury St. Edmunds. P4961 B

LADY TRACER, with 10 Years' Experience, REQUIRES POSITION in town or country.—Address, P4964, The Engineer Office P4964 B

MECHANICAL ENGINEER, with Good All-round general experience as foreman, cost clerk and manager, SEEKS responsible POST in any capacity, any district.—SNOAD, 36, York-road, Hitchin. P4990 B

ENGINEERS' TURNER, Age 26 Years, 11 Years' experience, DESIRES POSITION in Tool-room or Experimental Engineering Works. Accustomed to precision tool, experimental and interchangeable production work; two years' supervision in last position. —Address, P4943, The Engineer Office. P4943 B

ENGINEER MECHANIC (40), Experienced in Plant lay-out and general engineering, DESIRES responsible POSITION near London. Can take complete charge of plant and do all running repairs.—Address, P4999, The Engineer Office. P4999 B

FITTER, Young, 7 Years Apprentice on Railway. Credentials. Rebuilding and running repairs.—Write, S., 38, St. Leonard's-road, Northampton. P4972 B

PARTNERSHIPS

ENGINEERING PARTNERSHIPS AND BUSINESSES.

Wheatley Kirk, Price & Co.

46, Watling Street, London, E.C. 4.

Established seventy years.

CAPITAL WANTED and ORGANISER to Assist in Placing on Market Patent Padlock. Owner already agent about £3000 on same. Will stand strictest investigation; excellent opportunity.—Write, M. C., 272, Pentonville-road, King's Cross, London, N. 7514 C

EXTRA CAPITAL, Not Less than £2000 and Up to £10,000, offered for Partnerships and Directorships in really well-established businesses in town and country. A list of investors showing qualifications and money available sent.—OFFICERS PARTNERSHIP GUARDIAN, 110, Victoria-street, S.W. 1. Call. 7476 C

SECRETARY-DIRECTOR REQUIRED for Engineering Company, London. Investment £2000, fully secured. Salary £520 p.a. plus dividend. Open to solicitors' and accountants' investigations.—Write, Box 1587, Sell's, 167, Fleet-street, E.C. 4. 7493 C

AGENCIES

AGENTS WANTED to Sell Special Case-hardening Compound. Practical men. State experience and terms.—Address, 7549, The Engineer Office. 7549 D

AN Old-established Firm of Steel Casting Manufacturers REQUIRES an AGENT for the Sale of their production in Scotland. Headquarters in Glasgow preferred.—Address, with full particulars, P4963, The Engineer Office. P4963 D

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For continuation of For Sale Advertisements, see page viii.

Points from the Naval Treaty.

THE complete text of the Washington Naval Treaty being now available, it is possible to examine certain points of technical interest which did not appear in the digests cabled from America. Before passing on to the Treaty itself, we quote the following passage from a speech by Mr. Secretary Hughes, which appears in the official report of the plenary session of February 1st :—" Under the present Treaty Great Britain has stopped further construction and has abandoned the construction of the four new Hoods. Great Britain is permitted under the Treaty to have two new ships, but these are not ships of the size contemplated by the four Hoods, which was in the neighbourhood of 48,000 or 49,000 tons, and there are four ships to be scrapped when these two new ships are completed."

Considering the magnitude of the subject it deals with, the Treaty is by no means a lengthy document. Including the several tables appended to it, the full text would occupy about seven columns of a morning newspaper of the average size. It contains twenty-three articles, the majority subdivided into many sections. The opening articles concern the limitation of capital ships, the tonnage ratios agreed upon for the various Powers signatory to the agreement, and restrictions as to future displacement and gun armament. No new capital ship is to displace more than 35,000 tons—35,560 metric tons—or carry a gun in excess of 16in. calibre. The capital ship tonnage aggregates for the five signatory Powers are as follows :—United States, 525,000 tons ; British Empire, 525,000 tons ; France, 175,000 tons (177,800 metric) ; Italy, 175,000 (177,800 metric) tons ; Japan, 315,000 tons.

The tonnage aggregates for aircraft carriers are allotted as follows :—United States, 135,000 tons ; British Empire, 135,000 tons ; France, 60,000 (60,960 metric) tons ; Italy, 60,000 (60,960 metric) tons ; Japan, 81,000 tons. In the clause governing the replacement of aircraft carriers the following sentence occurs :—" . . . all aircraft carrier tonnage in existence or building on November 12th, 1921, shall be considered experimental, and may be replaced, within the total tonnage limit prescribed in Article VII.—as above—without regard to its age." In effect, permission is thus given to any signatory Power to scrap the whole of its existing fleet of aircraft carriers and proceed to replace the vessels at once, if so desired. Britain, for instance, could immediately lay down ten carriers of 13,500 tons each, or, conversely, twice that number of 6750-ton ships. The clause will be welcomed in naval circles, where it was feared that we should be saddled with a number of more or less obsolete aircraft carriers for some years to come, while other Powers, being well below their tonnage limits in this type, would be left free to build up-to-date vessels. It is further provided that no aircraft carrier to be laid down in future shall exceed 27,000 tons in displacement, but with this significant reservation :—" However, any of the contracting Powers may, provided that its total tonnage allowance of aircraft carriers is not thereby exceeded, build not more than two carriers, each of a tonnage of not more than 33,000 tons standard displacement ; and in order to effect economy any of the contracting Powers may use for this purpose any two of their ships, whether constructed or in course of construction, which would otherwise be scrapped under the provisions of Article II." This is taken to imply an intention of the United States naval authorities to convert two unfinished capital ships into aircraft carriers, the ships unofficially mentioned in this connection being the battle-cruisers Lexington and Saratoga, which are more advanced than their four sister ships. The wording of the clauses regulating the armament of aircraft carriers is somewhat involved, but we gather that each of these vessels may mount a battery of eight 8in. guns, or ten guns of a calibre intermediate between 8in. and 6in. If, however, no gun heavier than 6in. is mounted, the number of weapons in each ship is to be unlimited. No war vessel other than a capital ship or an aircraft carrier hereafter laid down for a signatory Power shall exceed 10,000 tons, nor shall it mount guns of more than 8in. calibre. These, therefore, represent the displacement and armament limits for future cruising ships. At the present time our largest vessels in this category—excluding the Glorious and Courageous—are those of the " Raleigh " class, viz., 9750 tons ; but it has been reported for some time past that the American Navy contemplated building cruisers of 10,000 tons with an 8in. armament, and designs of approximately similar character have been heard of from Japan. The largest cruising ships ever built for the British Navy were the Powerful and Terrible, of 14,200 tons.

In the tentative scheme submitted by Mr. Hughes at the first plenary session of the Conference it was proposed that no signatory Power should undertake warship construction on behalf of a foreign navy. This clause—which would have been justly resented by the British shipbuilding industry—has now been deleted, and it is merely agreed that no naval construction to foreign order shall exceed the limits of displacement and armament specified for future vessels of the signatory Powers. On the other hand, it is provided that " in the event of a contracting Power being engaged in war, such Power shall not use as a vessel of war any vessel of war which may be under construction within its jurisdiction for any other Power, or which may have been constructed within its jurisdiction for another Power and not delivered." It will be recalled that, on the outbreak of the late war, the British Government took over three battleships, several light cruisers, and smaller war vessels, and added them to the Royal Navy. The Treaty also forbids the sale or gift of any war vessel to be used as such in a foreign navy.

" Scrapping " is defined as placing a vessel " in such a condition that it cannot be put to combatant use," and three methods of effecting it are authorised, viz., (1) permanent sinking ; (2) breaking the vessel up, which must always involve the destruction or removal of all machinery, boilers, and armour, and all deck, side and bottom plating ; or (3) converting the vessel to target use. The " scrapping " provisions are amplified in great detail, and no loophole is left for keeping discarded ships in reserve against an emergency. When a ship falls due for scrapping she is to be deprived of her armament, other fighting equipment, and side armour—or alternatively her main propelling machinery—within six months, and scrapping is to be finally effected within eighteen months. On proposing to replace a capital ship or aircraft carrier, each signatory Power binds itself to communicate promptly to the others the following information : name of ship to be replaced, date of authorisation of new ship, date of laying the keel, the designed displacement, length at water line, beam, and mean draught. The details of armament, armour, &c., may apparently be withheld. If any capital ship or aircraft carrier is lost or accidentally destroyed, it may straightway be replaced by new construction, subject to the usual limits. Extensive reconstruction of existing ships of either of the types mentioned is prohibited, except for the purpose of providing defence against air and submarine attack, and subject to the following rules : bulge and additional deck protection may be added so long as the displacement increment does not exceed 3000 tons. No alterations in side armour, in the calibre, number or general type of mounting of main armament are permitted, except (1) in the case of France and Italy, which, within the limits allowed for bulge, may increase the armour and the calibre of the guns now carried on their existing ships, but no guns heavier than 16in. are to be mounted ; and (2) the British Empire is permitted to complete, in the case of H.M.S. Renown, the alterations to armour that have already been begun but temporarily suspended.

For the purposes of the Treaty a capital ship is defined as " a vessel of war, not an aircraft carrier, whose displacement exceeds 10,000 tons standard displacement, or which carries a gun with a calibre exceeding 8in." And " standard displacement " is that of the ship complete, fully manned, engined, and equipped ready for sea, including all armament and ammunition, equipment, outfit, provisions, and fresh water for crew, miscellaneous stores and implements of every description that are intended to be carried in war, but without fuel or reserve feed water on board. Among the miscellaneous provisions of the Treaty is the following :—" In view of possible technical and scientific developments, the United States, after consultation with the other contracting Powers, shall arrange for a conference of all the contracting Powers, which shall convene as soon as possible after the expiration of eight years from the coming into force of the present Treaty, to consider what changes, if any, in the Treaty may be necessary to meet such developments." The accompanying table shows the present and future position of the British Navy as affected by the scrapping and replacement clauses of the Treaty.

Replacement and Scrapping of Capital Ships, British Empire.

Year.	Ships laid down.	Ships completed.	Ships scrapped (age in parenthesis).	Ships retained. Pre-Jutland.	Ships retained. Post-Jutland.
—	—	—	Commonwealth (16), Agamemnon (13), Dreadnought (15), Bellerophon (12), St. Vincent (11), Inflexible (13), Superb (12), Neptune (10), Hercules (10), Indomitable (13), Temeraire (12), New Zealand (9), Lion (9), Princess Royal (9), Conqueror (9), Monarch (9), Orion (9), Australia (8), Agincourt (7), Erin (7), 4 building or projected*	21	1
1922	A, B†	—	.. ..	21	1
1923	—	—	.. ..	21	1
1924	—	—	.. ..	21	1
1925	—	A, B	King George V. (13), Ajax (12), Centurion (12), Thunderer (13)	17	3
1926	—	—	.. ..	17	3
1927	—	—	.. ..	17	3
1928	—	—	.. ..	17	3
1929	—	—	.. ..	17	3
1930	—	—	.. ..	17	3
1931	C, D	—	.. ..	17	3
1932	E, F	—	.. ..	17	3
1933	G	—	.. ..	17	3
1934	H, I	C, D	Iron Duke (20), Marlborough (20), Emperor of India (20), Benbow (20)	13	5
1935	J	E, F	Tiger (21), Queen Elizabeth (20), Warspite (20), Barham (20)	9	7
1936	K, L	G	Malaya (20), Royal Sovereign (20)	7	8
1937	M	H, I	Revenge (21), Resolution (21)	5	10
1938	N, O	J	Royal Oak (22)	4	11
1939	P, Q	K, L	Valiant (23), Repulse (23)	2	13
1940	—	M	Renown (24)	1	14
1941	—	N, O	Ramillies (24), Hood (21)	0	15
1942	—	P, Q	A (17), B (17)	0	15

* The British Empire may retain Colossus and Collingwood for non-combatant purposes after they have been dismantled of fighting equipment.

† Two 35,000-ton ships, standard displacement.

NOTE.—A, B, C, D, &c., represent individual capital ships of 35,000 tons standard displacement, laid down and completed in the years specified.

Developments in Power Station Design.

No. XXIV.*

IT is, of course, well known that the greater part of the heat contained in the coal used in power stations is lost, a comparatively small portion passing away up the chimney and the greater portion in the circulating water *viâ* the condenser. In due course use may be made of a substance which will give a greater temperature range than that of water. The gas turbine may possibly offer a solution to the problem, but progress in the development of that machine has so far been slow and disappointing. One of the most interesting schemes that have been put forward within recent years is that devised by Mr. L. R. Emmet, who employs mercury vapour at a high temperature to drive a simple turbine which exhausts into a " condenser boiler " in which steam is raised for driving a second turbine. In this way a considerable temperature range is utilised and a high efficiency is secured with simple turbines. A fair sized experimental plant working on these lines has been constructed at Schenectady, and although the risk of poisonous mercury fumes escaping is said to have been eliminated, the scheme does not seem to have attracted a great amount of attention in engineering circles.

A step towards improving the efficiency of power stations has, however, been made by the utilisation of high steam pressures. In a station on the Tees-side a steam pressure of 450 lb. has been adopted, and pressures in the neighbourhood of 300–350 lb. are being employed in various other stations, such, for example, as in the Nechells station belonging to the Birmingham Corporation. The trend in steam turbine design is to work with high pressures and superheats, and, of course, to keep down the back pressure to the lowest value practicable, so that the turbines may work between greater temperature limits. An experimental high-pressure turbine was designed in 1913 by Mr. F. Samuelson, the engineering manager of the turbine department of the British Thomson-Houston Company. The machine, which was coupled to a turbo-alternator with a capacity of 1500 kilowatts, was put into service in 1914, and it was originally intended to work at a pressure of 500 lb. per square inch ; but after consultation with Babcock and Wilcox, Limited, a compromise pressure of 350 lb. was adopted, the steam being superheated to a total temperature of 700 deg. Fah. The turbine, which was a standard machine, slightly modified to suit the higher steam pressure conditions, was found to operate so satisfactorily and economically that it was decided to retain it as a generating unit in the company's power-house, where it has since run continuously and has only been shut down for the usual overhauls and inspection. For supplying steam to the unit a 18,000 lb. Babcock self-contained marine type boiler is used, with the superheater and economiser sections inside the single casing and fitted with a chain-grate stoker and induced draught. Tests on the boiler have shown an efficiency ranging from 80 to 83 per cent., whilst tests on the turbine have given a consumption of 11.2 lb. per kilowatt-hour at full load, with 350 lb. per square inch gauge pressure, a total steam temperature of 700 deg. Fah., and a vacuum of 28½in. If, instead of using standard parts to a considerable extent, the turbine had been designed throughout for the higher

* No. XXIII. appeared February 10th.

pressure, the steam consumption would have been reduced by about 3½ per cent. It has, however, been found that, notwithstanding the small size of this set and the varying load and power conditions in the works, the saving in coal is considerably more than the 15 to 18 per cent. expected.

Owing to the success of this experimental plant considerable interest in higher steam pressures was aroused, and Mr. Sparks, the consulting engineer to the Powell Duffryn Steam Coal Company, Limited, decided to install sets working under the same conditions, viz., 350 lb. pressure and 700 deg. Fah., in that company's new Bargoed central power station, which is intended to supply power to a large number of the South Wales collieries by means of an extensive system of overhead lines working at pressures of 30,000 and 10,000 volts. The first turbine to be ordered from the British Thomson-Houston Company has a capacity of 6000 kilowatts at a speed of 3000 revolutions per minute, and the following steam consumptions were guaranteed when working at a steam pressure of 350 lb. per square inch, a temperature of 700 deg. Fah., and a vacuum of 28½in.:—6000 kilowatts, 10.6 lb. per kilowatt-hour; 5000 kilowatts, 10.25 lb. per kilowatt-hour; 3750 kilowatts, 10.7 lb. per kilowatt-hour; 2500 kilowatts, 11.6 lb. per kilowatt-hour. These consumptions cover all the losses in the turbine, alternator and exciter, but not the steam used by auxiliaries. The total weight of the steam and electrical portion of the set, including the bed-plate, is 75 tons. The set was put into commission in December, 1920, and since that time it has proved itself economical and otherwise satisfactory. Owing to the use of brass blade spacers a certain amount of trouble developed when the set was first put into use, because the spacers were unsuitable for the high temperatures; but when they were replaced by steel spacers the original trouble was overcome. A surface condensing plant made gallons of circulating water per minute at an inlet temperature of 75 deg. Fah. The condenser is of the three-flow rectangular cast iron type with a tube surface of 7500 square feet. A 100 brake horse-power slip-ring induction motor running at 720 revolutions per minute drives the 16in. vertical spindle circulating pump with a capacity of 5650 gallons per minute. The hydraulic vacuum air pump and rotary extraction pump are also driven by a British Thomson-Houston motor of the same type, but rated at 60 brake horse-power and 720 revolutions per minute. The extraction pump is capable of dealing with 140 gallons of condensate per minute when working against a head of 35ft. Before entering the tanks the feed water passes through a B.T.H. feed-water heater, which is constructed generally on the lines of a surface condenser with Admiralty type tube plates and packings.

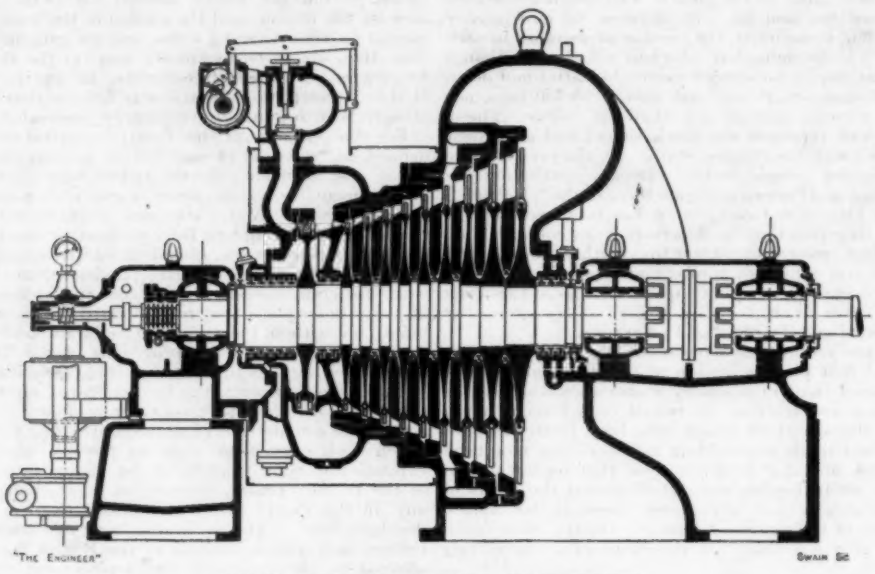


FIG. 115—B.T.H. HIGH-PRESSURE STEAM TURBINE

Since the installation of this high-pressure turbine a second similar machine has been ordered from the British Thomson-Houston Company. This machine, which is rated at 12,000 kilowatts, is designed for a speed of 1500 revolutions per minute and the operating conditions are the same as those of the first set, with the exception that a vacuum of 28in. is employed instead of 28½in. The steam consumption for this turbine under the conditions stated, *i.e.*, 350 lb. per square inch, a total temperature of 700 deg. Fah., and a 28in. vacuum, are as follows:—12,000 kilowatts, 10.55 lb. per kilowatt-hour; 10,000 kilowatts, 10.45 lb. per kilowatt-hour; 7500 kilowatts, 10.75 lb. per kilowatt-hour. The above figures are based on a load at 100 per cent. power factor and include the turbine, alternator, and exciter losses, but not the power taken by the auxiliaries. At a power factor of .8, the rating of the alternator is 15,000 kilovolt-ampères. The turbine has seventeen stages and the weights of the steam and electrical ends are about 92 and 90 tons respectively. The design of the 12,000-kilowatt machine is similar to that of the smaller machine, but special consideration has been given to the selection of suitable materials to withstand the high steam pressures and temperatures. Cast steel is employed for the main turbine casing and valve chests, and the nozzle diaphragms down to the fifth stage are also composed of cast steel, with the steel nozzle plates cast in solid.

Only the first stage nozzles are made of malleable cast iron. No gun-metal or brass is used anywhere in the vicinity of high temperature steam, mild steel having been adopted for all details, such as glands, bushes, &c. In both cases the steam is supplied to the turbine through a single steam inlet, and an interesting feature of these high-pressure turbines is the relatively small size of the steam piping required. The piping supplied for these machines is only 9in. in diameter, whereas turbines of the same capacity working under more normal conditions require 12in. diameter pipes. The nozzle control gear is operated by a centrifugal governor through oil relay gear and is designed to limit the fall or rise in speed to under 5 per cent. momentarily and 2½ per cent. settled speed, when full load is switched on or off and the speed variation from the normal will not exceed half per cent. with constant load or 1½ per cent. with sudden load variation. Hand and motor

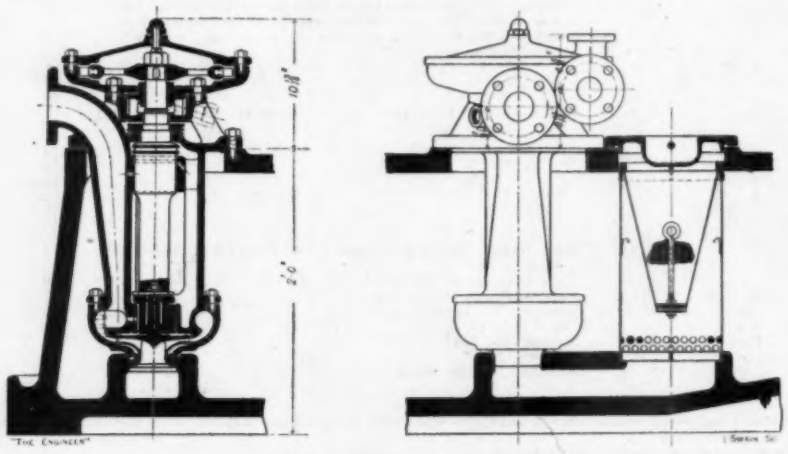


FIG. 117—CENTRIFUGAL OIL-PUMP

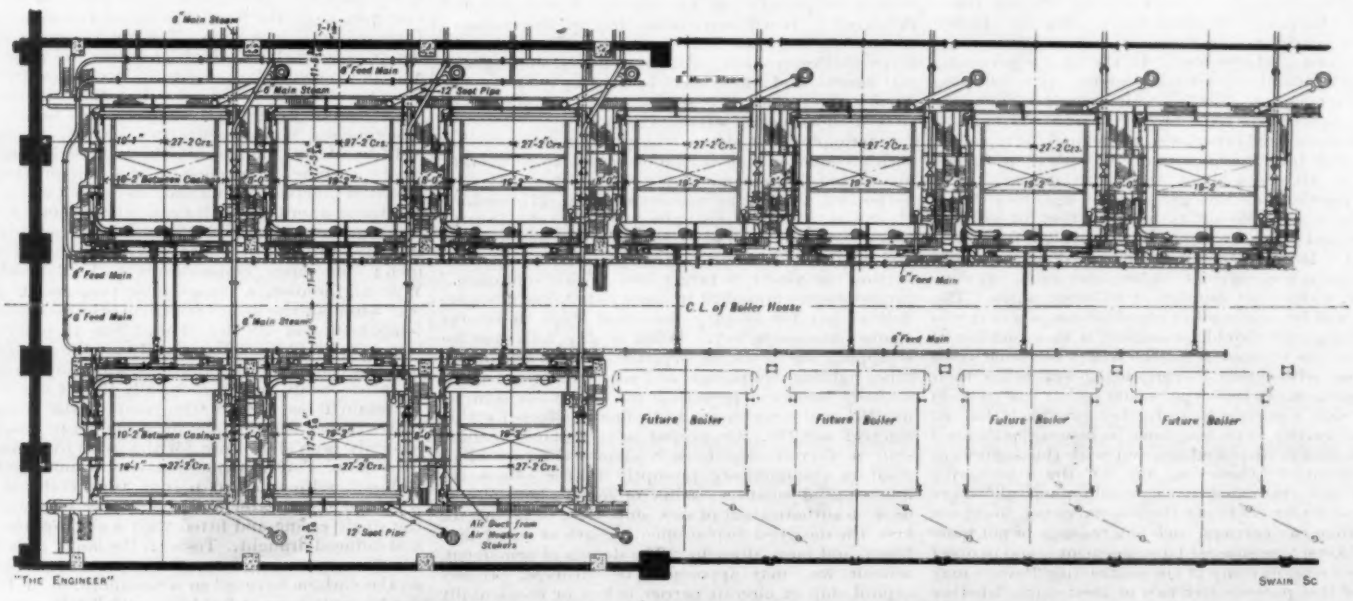


FIG. 116—PLAN OF BOILER HOUSE AT BARGOED POWER STATION

by Worthington-Simpson, Limited, is used in conjunction with the unit. It is designed to deal with 65,000 lb. of steam per hour and is capable of maintaining a vacuum of 28½in. when supplied with 5650

control gear allow the speed to be adjusted within the limits of 5 per cent. above and below normal speed, and the emergency governor operates at 10 per cent. excess speed. Owing to the size and weight of the complete stator the electrical end had to be erected on site, as the weights are greater than can be dealt with by the railways. The steam end has, however, been assembled and run in the British Thomson-Houston Company's works.

The condensing plant for the 12,000-kilowatt turbine is being supplied by G. and J. Weir, and it is of the Weir influx two-flow type and capable of maintaining a vacuum at the turbine exhaust flange of 28in. with the barometer at 30in. and when supplied with 12,200 gallons of circulating water per minute at an inlet temperature of 75 deg. Fah. and when dealing with 130,000 lb. of steam per hour. The tube surface is 15,700 square feet. A steam-driven circulating pump passes 6300 gallons of water per minute through the condenser and 200 gallons per minute through the oil cooler. There is also a motor-driven Drysdale centrifugal pump having a similar capacity and capable of delivering against a total head of 55ft. A steam turbine-driven extraction pump of the Weir vertical rotary type has been installed to withdraw the water from the condenser and to deliver it to the direct contact feed-water heater. This pump, which is capable of dealing with 130,000 lb. of condensate per hour, is intended to serve as a stand-by to an electrically driven Drysdale horizontal extraction pump of similar capacity, and is coupled to a British Thomson-Houston squirrel-cage induction motor. A Weir steam air-ejector is provided for maintaining a vacuum of 28in. A second ejector serves as a stand-by. Each ejector is capable of maintaining the above vacuum when the condenser is taking 130,000 lb. of steam per hour. Before entering the feed tanks the feed water passes through a Weir direct contact feed-water heater, which is fitted on the discharge side of the extraction pump and utilises the exhaust steam from the circulating pump turbine, water extraction pump turbine, and evaporator, and is augmented by exhaust steam of a higher temperature bled from the low-pressure end of the turbine. It is interesting to note that in addition to several machines designed to operate at steam pressures from 250 lb. to 300 lb. at temperatures of about 700 deg. Fah., the British Thomson-Houston Company is supplying two 15,000-kilowatt units to the Birmingham Corporation for the Nechells station, which sets are to work at a pressure of 325 lb. per square inch and at a temperature of 750 deg. Fah.

The general design of the high-pressure turbines supplied to the Powell Duffryn Steam Coal Company is the same as that of the machine described in our issue of June 2nd, 1921, and shown in Fig. 115, but the 12,000-kilowatt set is fitted with a centrifugal oil pump as shown in Fig. 117. Escher, Wyss and Co. are also installing a high-pressure turbine in this station.

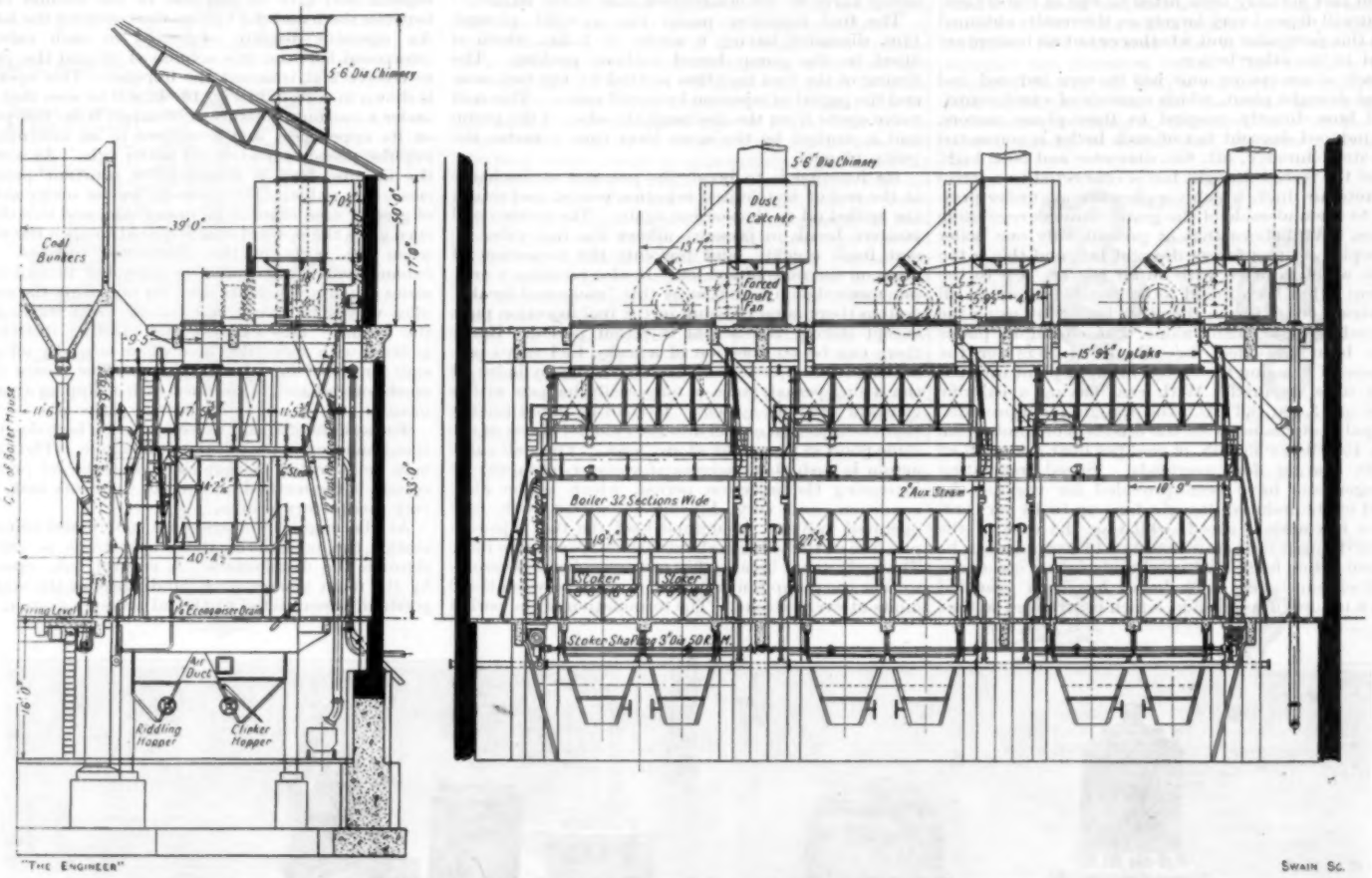


FIG. 118—VERTICAL SIDE AND FRONT SECTIONAL ELEVATIONS OF BOILERS AT BARGOED POWER STATION

Provision has been made at the Bargoed power station for the installation of fourteen steam-raising units, each having a normal evaporative capacity of 35,000 lb. of steam per hour and working at a pressure of 350 lb. per square inch. Besides supplying the steam for the electrical plant, the boilers are also to provide steam for three large turbo-driven air compressors for giving a supply of compressed air to the various collieries in the district. Each boiler, which is identical in design and construction, is of the Babcock and Wilcox patented steel-cased marine type with a heating surface of 4480 square feet and equipped with an overhead steel economiser and an integral superheater, which gives a final steam temperature of 750 deg. at the outlet. Each boiler is also equipped with two Babcock chain-grate enclosed type balanced draught mechanical stokers with a total grate area of 240 square feet. The general arrangement of the boiler-house is shown in Figs. 116 and 118, whilst

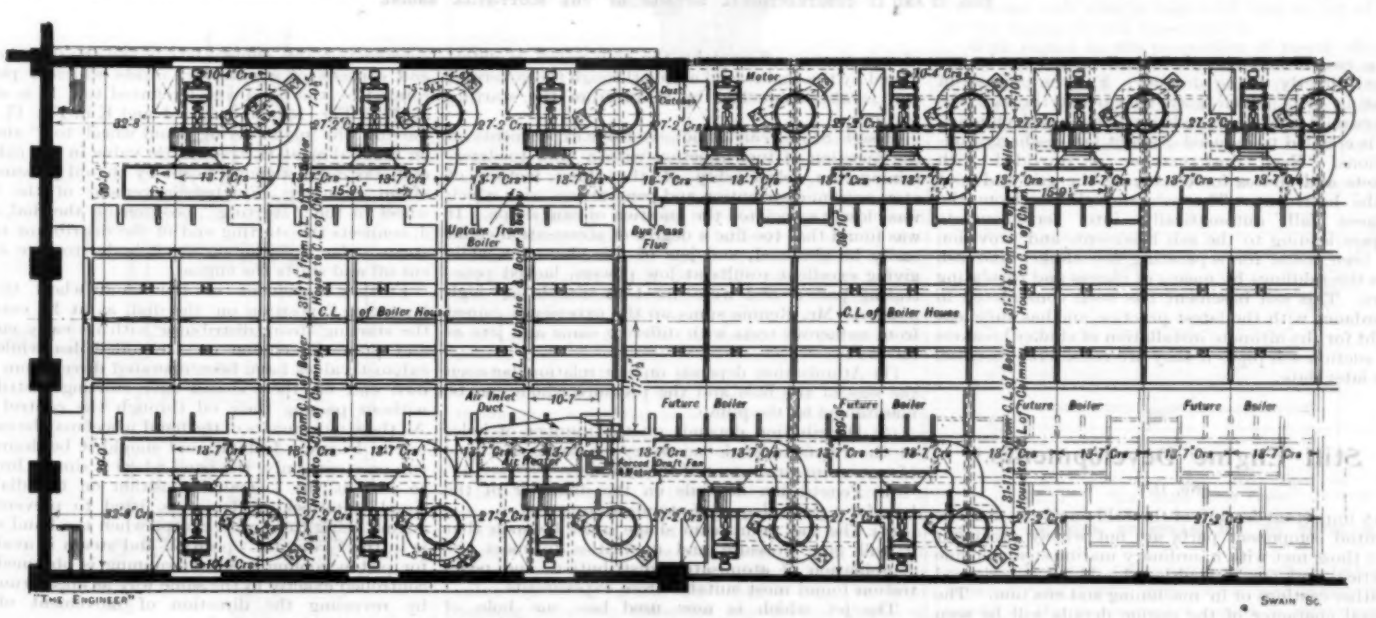


FIG. 119—ARRANGEMENT OF FANS AND CHIMNEYS AT BARGOED POWER STATION

Fig. 119 gives a plan of the fan and chimney platform. Each steam-raising unit, comprising the boiler, superheater, economiser and stoker, is enclosed in a steel casing, which is accessible from all sides, and it will be seen from the drawing Fig. 119 that provision has been made for the introduction of air heaters at a later date if they are considered desirable. An air heater has in fact actually been fitted to one of the boilers, and it will depend very largely on the results obtained with this particular unit whether or not air heaters are fitted to the other boilers.

Each steam-raising unit has its own induced and forced draught plant, which consists of cased centrifugal fans directly coupled to three-phase motors. The induced draught fan of each boiler is connected to a steel chimney, 5ft. 6in. diameter and 50ft. high, whilst the forced draught fan is connected to a ferro-concrete air duct, which supplies the air under pressure to the underside of the grates through regulating valves. We believe that at present only one boiler is coupled up to a forced draught fan, and this is the boiler which is fitted with an air heater. Up to the present it has been found to be possible to obtain all the steam desired from the other boilers by using the induced draught plant alone, but closing-in plates have been provided for all the boilers for the purpose of bringing the forced draught plant into use when it is required. With coal having a calorific value of 13,000 B.Th.U.'s the draught plant provided is capable of dealing with the products of combustion from 4300 lb. to 5500 lb. of coal per hour and with an ample margin for overloads. Speed regulating arrangements have been provided for varying the speed of the induced draught fans up to 18 per cent. above the normal speed, whilst in the case of the forced draught fans an increase of 15 per cent. can be secured. For light load conditions or for use under other circumstances each boiler has been provided with a natural draught flue, which is arranged so that in the case of necessity the exhaust gases can be bypassed directly to the chimney. For the purpose of arresting grits which may be carried through the boiler a mild steel dust-catcher is fitted in each chimney and is coupled to induced draught fan discharge connections. Each dust-catcher is provided with pockets and chutes for conveying the grit and soot to the basement. The ash and clinker from the furnaces fall automatically into ferro-concrete hoppers leading to the ash basement, and provision has been made for separating the clinker and ash from the riddlings by means of chutes and regulating doors. This ash basement has been constructed in accordance with the latest practice, and has sufficient height for the ultimate installation of clinker breakers and suction ash pipes if they are considered essential at a later date.

Still Engine Developments.*

No. II.†

AN important feature of the Still engine is that the essential component parts are not widely dissimilar from those met with in ordinary marine steam engine practice, and few difficulties should be experienced in either castings or in machining and erection. The general character of the engine details will be seen from the photographs we reproduce in Figs. 12 and 13.

Turning to the valve gear, it is to be noted that when the engine is running, the only valves in operation are the fuel injection valve on the combustion side and the steam exhaust valves on the steam side. The former is worked automatically by the fuel-injection pressure and the latter by a system of oil under pressure. The fuel injection valve, which is of the spring-loaded type and is fitted to a conical seat formed on the upper end of the combustion cylinder liner, is shown in section in Fig. 14. The fuel valve casing carries relief valve and indicator connections, and is secured to the top of the cylinder mantle through heavy springs which allow of the valve adjusting itself to suit temperature conditions, and also enables the complete valve unit to act as a safety valve to the combustion side of the engine.

The fuel injection pump has a solid plunger 1¼in. diameter, having a stroke of 1.3in., which is fitted to the pump barrel without packing. The timing of the fuel injection is fixed by the fuel cam, and the period of injection by a spill valve. This spill valve opens from the discharge chamber of the pump and is worked by the same lever that actuates the pump plunger.

Its function is to break the pressure of discharge at the end of the desired injection period, and return the spilled oil to the suction again. The sudden and positive break in pressure allows the fuel valve to seat itself quickly, and prevents the formation of drips on the nose of the jet. It also provides a very safe method of injection, as by this "make and break" system there is no pressure in the fuel injection pipe, except during the actual injection period. Hence there can be no question of a leaky fuel valve permitting the injection of fuel into the cylinder at the wrong period, such as may easily happen with a constant pressure system. It is to be noted further that the injection of fuel into the cylinder starts at the same point in the stroke at any load. The spill valve action is such that increase of power is obtained by increasing the injection period, which is the ideal condition, and very difficult to attain with cam operated valves. At normal load the fuel injection pressure at the valve is about 6000 lb. per square inch. The spill valve breaks this to atmospheric pressure, so that the pump builds up its pressure between these limits at every stroke. The termination of the period of injection as effected by the spill valve is determined by the engine load acting through the governor, and is also controlled by hand from the starting platform.

Messrs. Scotts carried out extensive experiments on the question of fuel injection with a view to determining the relationship of the three factors of atomisation, distribution and penetration, with which was closely associated the question of cam shape. It was found that too fine a degree of atomisation could easily be obtained, and jets of this character, while giving excellent results at low powers, lacked penetrating power, and were most unsuitable at high powers. Mr. Rennie sums up the experience gained from numerous tests with differing cams and jets as follows:—

(1) Atomisation depends on the relation between the size of the hole and the pressure which can be maintained by the pump.

(2) Distribution depends on the number of holes at the requisite angle necessary to cover the zone of maximum air content of the cylinder.

(3) Penetration depends on the diameter of the hole for a given degree of atomisation.

(4) The fuel pump cam shape must be such that it will give pressure and quantities to meet the combination of atomisation, distribution, and penetration found most suitable from experiments.

The jet which is now used has one hole of 20/1000in. diameter in its centre, surrounded by a ring of eight holes, each of 24/1000in. diameter lying at an angle of 45 deg. to the vertical.

The oil pressure system for operating the steam inlet and exhaust valves is worthy of special consideration, as it eliminates all lay shafts, excentrics, rods and such-like mechanism, and substitutes therefor operation by oil power. The arrangement is shown diagrammatically in Figs. 15 and 17, and is worked as follows:—A simple plunger type of pump worked from the main shaft supplies oil at a pressure of from 350 lb. to 450 lb. per square inch to the valves to be operated. The oil passes from the pump through a distributor worked by spiral gearing from the main shaft. Separate distributors are provided for the steam inlet and exhaust valves. These are shown in Fig. 15 at A and B, and sectionally in C and D, Fig. 17. The ports are so arranged in the cylinder and piston that once per revolution they register and give an impulse to the column of oil between them and the valves, thus opening the latter. An operator directly connected to each valve is interposed between this column of oil and the valve, to receive and transmit the impulse. This operator is shown in section in Fig. 16. It will be seen that it is under a constant pressure of oil direct from the pump on its upper side, and is subject to an intermittent impulse pressure load on its under side. As soon as the impulse load is released the constant pressure closes the valve. The operator on its under side is of greater area than on its upper side, and this difference gives the upward load required to open the valve when the ports in the distributor register. The exhaust valve distributor is extended to include a series of ports which are used for operating the steam inlet valves to give a late cut-off when starting up the engine. This exhaust and starting distributor is fitted with a shuttle valve which is set by oil pressure for ahead or astern running. The steam inlet, on the other hand, is provided with a slipping arrangement on the plug coupling for this purpose.

The system of steam valve operation here described is not an integral part of the Still engine. The valves may be operated mechanically, but the oil pressure system is the method adopted in the Scott unit, with very satisfactory results.

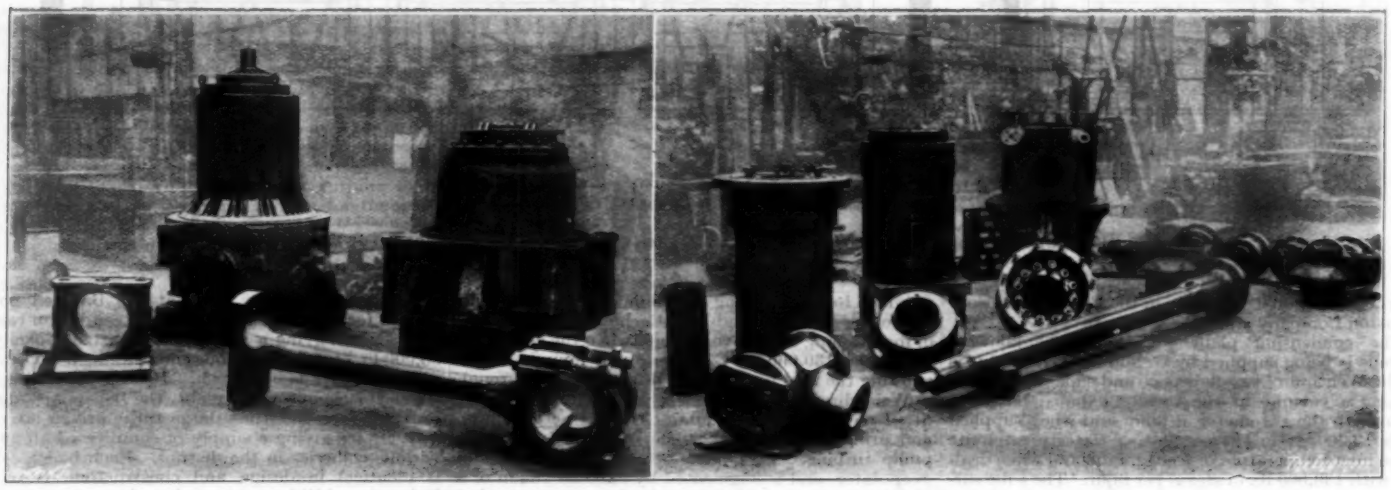
As the engine is started up and manœuvred by steam, the control of these operations is effected through the distributors. A control box, operated by the main manœuvring hand wheel at the starting position, is connected to the oil pressure system. In construction this control box is like the distributors, and consists of a cylinder, inside which a plug is rotated by the hand wheel referred to. It is shown at F in Fig. 15 and at H, J and K in Fig. 17. On moving the manœuvring hand wheel to "ahead" on the dial as at H, the shuttle valve in the exhaust and starting distributor is set by the oil pressure for ahead running. Further movement of the hand wheel to the "starting" position on the dial, as at J, connects the starting end of the distributor to the steam valve operator on the cylinder to give a late cut-off and starts the engine.

Further movement of the hand wheel to the "running" position on the dial, as at K, cuts out the starting steam distributor with its early cut-off, and puts the engine on fuel oil. Meanwhile the exhaust valves have been operated direct from their own end of the exhaust and starting distributor without passing their oil through the control box. All these movements of the hand wheel may be carried out in leisurely fashion, and should it be desired to run on steam only, the hand wheel is simply brought to rest at the "steam" position on the dial. A simple interlocking device is fitted to prevent the engine being run on oil except when the hand wheel is in the "running" position and steam is available for piston cooling. Astern running is obtained and controlled exactly in the same way as ahead running, by reversing the direction of movement of the manœuvring hand wheel.

During the process of starting up and manœuvring, the oil pressure supply is obtained from an independently driven stand-by pump.

Reversal of the fuel pump action is obtained by fitting a separate astern cam and moving the cam roller from one cam to the other.

This is done in the single-cylinder engine by hand gear, which is special to that unit. In a multi-cylinder engine the moving of the roller will be effected by the steam valve oil-pressure system, and will occur at the same time, and by the same move-



FIGS. 12 AND 13—CONSTRUCTIONAL DETAILS OF THE SCOTT-STILL ENGINE

* Abstract from paper read by Mr. Archibald Rennie before the Institution of Engineers and Shipbuilders in Scotland.

† No. I appeared February 17th.

ment of the manœuvring hand wheel as sets the steam valve distributors for astern running.

The only other auxiliary gear in addition to the fuel injection pump, and the valve gear operating pump already referred to, consists of a forced lubrica-

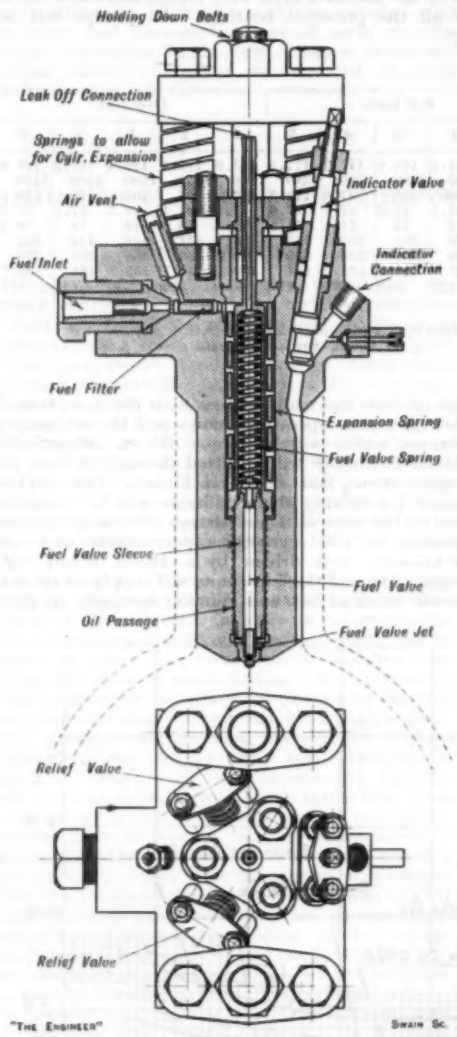


FIG. 14—FUEL INJECTION VALVE

tion pump and a scavenging air blower for the combustion side, and for the steam side a small condenser with air, circulating and feed pumps, and a regenerator with feed heater, filter circulating pump and filters. On the experimental unit all the

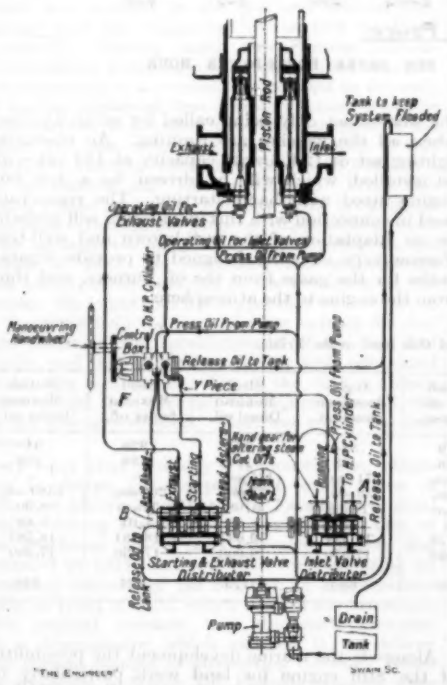


FIG. 15—DIAGRAM OF OIL VALVE-CONTROL SYSTEM

moving auxiliaries, with the exception of the scavenging air blower, were driven from the engine itself.

The regenerator adopted is a small Cochran boiler of 150 lb. working pressure, 5ft. 6in. in diameter, and 300 square feet surface. The feed heater is of simple tubular design and 228 square feet surface.

Scavenging air is supplied by a small electrically driven turbo-blower specially designed for experimental use, having a normal output of 1500 cubic feet of free air per minute at a pressure of 2½ lb. per square inch. Field regulation is provided to allow of a range of output and pressure from 1200 cubic feet at 1½ lb. pressure per square inch to 2000 cubic feet at 3½ lb. pressure per square inch. The scavenging air from the blower is led to the bed-plate, thence up the columns to the ports in the combustion cylinder liner. The bed-plate and columns are thus used as a scavenging air reservoir. The exhaust gases from the combustion side of the experimental engine are led through a water-jacketed pipe of 12½in. bore to the regenerator, thence to an auxiliary regenerator and the feed water heater to atmosphere. The auxiliary regenerator was provided, as it was thought that the surface in the Cochran boiler might not be large enough to extract a satisfactory maximum of heat from the gases. This presumption, however, was not borne out in practice, and the auxiliary regenerator was therefore put in circuit with the feed heater at the first opportunity, and used in that capacity in the later trials. A direct connection for the gases from the regenerator is also provided, but is used only when raising steam by oil burner for starting up from cold.

On the steam side a shut-off stop and throttle valve is inserted in the main steam pipe from the regenerator. The stop valve is used simply to give control over the steam pressure carried in the regenerator, whilst the throttle valve is connected to the

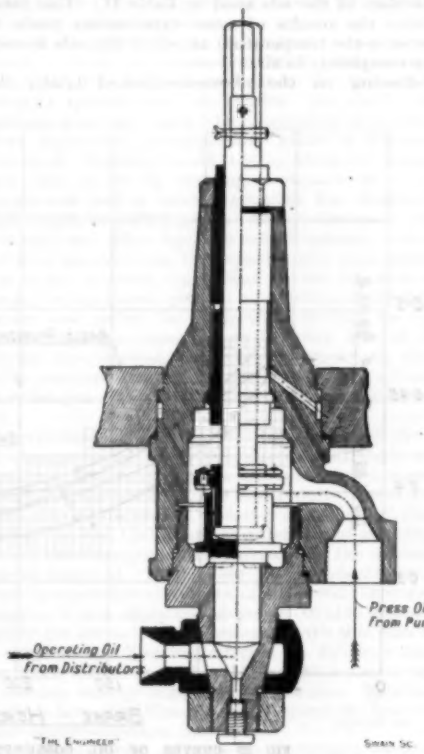


FIG. 16—SECTION OF VALVE OPERATOR

governor. The governor is of the common ball type, which, acting through a servo-motor, controls the setting of the spill valve on the fuel injection pump.

It is adjusted by means of a small hand wheel control passing through the centre of the main manœuvring hand wheel, and may be set by that means to control the speed of the engine at any revolutions from about 50 to 130 per minute. Independent hand control of the spill valve is also arranged. The servo-motor receives its power from the forced lubrication system. On the steam side the governor acts as a simple cut-out at maximum revolution, and operates on the throttle valve.

In starting from cold, the burner under the regenerator is lighted and steam is raised as in an ordinary boiler. As soon as the temperature in the regenerator begins to rise, it is found that a natural thermal circulation of the water between it and the cylinder takes place, so that by the time the steam is raised the engine is thoroughly warmed up.

The actual starting of the engine is then accomplished by means of the manœuvring hand wheel in the manner already explained when describing the valve operating gear. The engine may be kept running on steam alone for any desired length of time, or fuel may be cut in at once, and the engine brought up to the required speed. The cutting in of the fuel is accomplished simply and easily by means of the governor or hand lever control, already referred to, acting on the spill valve. This valve may be so set that all the oil pumped by the fuel pump is spilled—none going to the fuel valve; or, again, it may so be set that all the oil pumped is sent to the fuel valve and none spilled. Between these limits any setting of the spill valve may be obtained to suit the load being carried by the engine.

Among other interesting tests carried out on the experimental unit were those to determine the weight of steam generated on test. The quantity of steam generated from waste heat by the single cylinder is 800 lb. per hour at 120 lb. pressure per square inch, when the combustion cylinder is working with about 80 lb. mean pressure, equal to a normal load of about 340 brake horse-power. It increases as the load is increased, and falls away as the load is reduced, until at about 35 lb. mean pressure in the combustion cylinder, just sufficient heat is being recovered to equalise the radiation losses. This is quite to be expected for, as the load is reduced, the quantity of fuel oil burned is less and the waste heat available for steam generation is, therefore, less. At the same time it should be noted that, at mean pressures of

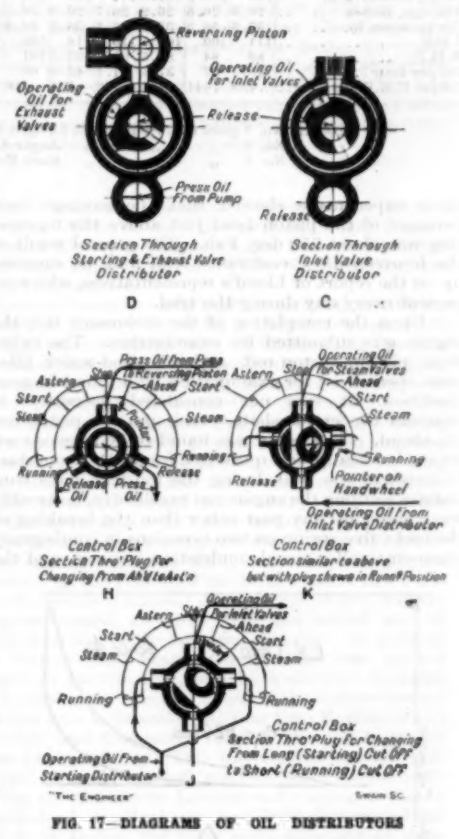


FIG. 17—DIAGRAMS OF OIL DISTRIBUTORS

about 40 lb. and under in the combustion cylinder, no steam is necessary for piston cooling, the rate of heat transfer by contact with the cylinder wall being sufficient to keep the piston cool. During all trials it was noted that whenever the combustion side fell off in efficiency, as, for example, when different fuel jets were being tried and combustion was not good, the steam side always improved, responding at once to the increased fuel consumption.

With regard to the proportion of power obtained from the steam side, it will be observed that this amounts to about 12 per cent. of the total horse-power at full normal load. This, for obvious reasons is not so high as would be obtained from a multi-cylinder engine when from 15 to 20 per cent.

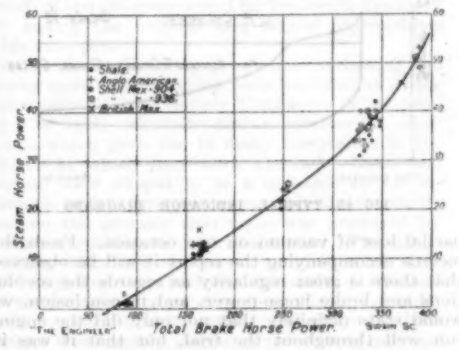


FIG. 18—RELATION OF STEAM H.P. TO TOTAL B.H.P.

may be expected. A curve showing the relationship between total brake horse-power and steam horse-power in the experimental engine is reproduced in Fig. 18.

Several whole day trials of about eight hours duration have been run, representative of which are the trials carried out by a committee of French engineers and the trials by Captain H. Riall Sankey, published in our last issue. Fig. 19 shows a series of typical indicator cards taken during a fourteen days' endurance trial run from August 24th to September 7th, 1921. These cards were taken at full normal load, the engine running at 120 revolutions per minute, with a steam pressure of 120 lb. per square inch and a vacuum of 27.5in. Under these con-

ditions the indicated steam horse-power developed was 41.2 and the indicated combustion horse-power 344, giving a total of 385.2 indicated horse-power or 336 brake horse-power.

During this trial and later the temperature of the piston was measured by inserting small pieces of metal having various melting points into drilled and plugged holes in the piston head. The results of these experiments showed that the average temperature of the piston head just above the topmost ring was about 750 deg. Fah. The general result of the fourteen days' endurance trial may be summed up on the report of Lloyd's representatives, who were present every day during the trial.

"Upon the completion of the endurance test the engine was submitted for examination. The cylinders, piston, piston-rod, and the feed-water filter were opened out for examination, and found in good condition. It was not considered necessary to examine the crank shaft, crank pin, or piston-rod crosshead. The boiler was found to be in good condition internally and quite free from oil. From start to finish of the trial during the fourteen days' continuous working the engine ran excellently, no trouble was caused by any part other than the breaking of the fuel valve spring on two occasions (a contingency common to all internal combustion engines), and the partial loss of vacuum on one occasion. From the records accompanying the report it will be observed that there is great regularity as regards the revolutions and brake horse-power, and, in conclusion, we would state definitely that not only did the engine run well throughout the trial, but that it was in thoroughly good condition at the finish."

With regard to the two short stoppages occasioned by the breaking of the fuel valve spring it may be stated that in a multi-cylinder engine a stop would not have been necessary to change the spring, but in the single-cylinder engine it was deemed advisable to do so.

During all trials up to September, 1921, the oil fuel used was shale, having a calorific value of about 19,300 B.Th.U. gross (18,240 net), and a specific gravity at 60 deg. Fah. varying from 0.85 to 0.87.

In order to test the performance of the engine when using heavy oils, a series of eight-hour trials, using different grades of heavy oils, was commenced on October 20th, 1921, at one of which trials we had the pleasure of being present. No adjustments were made to the engine prior to or during these trials, and the same cam and fuel valve settings as had been found most suitable for shale oil were used throughout.

It was noticed, however, that as each grade of oil was succeeded by a heavier one, the volumetric efficiency of the fuel pump fell off, and consequently the point of injection gradually became later. The results, therefore, are not so good as they would be with proper settings. When, however, they are equated to a common standard net calorific fuel value, they fall quite closely into line with each other, showing that the overall efficiency is not much affected as between the different oils. The results of these trials are given in Table I. and Fig 20, and the particulars of the oils used in Table II. This table includes the results of some experiments made to determine the temperature at which the oils burned away completely in air.

Following on the above-mentioned trials, the engine was again opened up for examination of the internal parts, and was found to be in excellent condition. The piston rings were all free and clean and no carbon deposit or other evidence was found to suggest that the engine would have any difficulty in running with any of these oils for long periods.

From the account of the trials and performance of the Scott-Still experimental unit, there is no doubt that the experimental stage has now been passed, and Messrs. Scotts are ready to embody the valuable results of the past eighteen months trials in new engines specially designed to suit marine conditions. It was with pleasure that we were able to announce in our Scottish letter* at the beginning of the month that Messrs. Alfred Holt and Co., of Liverpool, had placed an order with Scott's Shipbuilding and Engineering Company, Limited, of Greenock, for the construction of a 400ft. twin-screw vessel to be fitted with Scott-Still engines developing a total brake horse-power of 2500 at a speed of from 115 to 120 revolutions per minute under ordinary service conditions. We are given to understand that each set of main engines will have four cylinders, 22in. in diameter, with a stroke of 36in. The engines will be of the enclosed type with forced lubricator fitted to all the principal bearings. All pumps will be driven from the main engines with the exception of the valve gear operating pumps and the scavenging blowers, which will be motor driven. Electrically driven auxiliaries will be fitted throughout both for engine-room and deck machinery. The electric power for driving the auxiliaries will be furnished by two 160-kilowatt Diesel-driven 220-volt generators running at 250 revolutions per minute and one 50-kilowatt unit driven by a Diesel or hot bulb engine. One of the large units will supply all electric power when at sea and running normally in port, the smaller set only being called for as an auxiliary when all the winches are running. An emergency lighting set of 12-kilowatt capacity at 110 volts will be installed, which will be driven by a hot bulb engine fitted with hand starting. The regenerator used in connection with this installation will probably be an adaptation of the well-known and well-tried Yarrow type of boiler designed to provide separate paths for the gases from the oil burners, and those from the engine to the atmosphere.

Alongside the marine development the possibilities of the Still engine for land work, particularly for central power station, must not be overlooked. Reference to Fig. 20 will confirm that the efficiency curve is remarkably flat over a wide range of load, because the rapid falling off on the combustion side above full load is compensated for by the gain on the steam side. The Still engine can carry heavy overloads by simply burning additional fuel under the

TABLE I.—*Scott-Still Engine Trials with Various Oils.*

	One-quarter load.					Half load.					Three-quarter load.					Full load.					Overload.				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Revs. per minute	83.8	79.1	81.6	85.9	88.3	94.9	93.3	97.7	98.3	100.4	110.3	111.1	109.3	111.8	110.0	124.5	122.2	121.8	117.3	122.5	121.6	129.6	129.4	128.3	127.6
Load, lb.	530	530	530	530	530	850	850	850	850	850	1125	1125	1125	1125	1125	1380	1380	1380	1380	1380	1400	1500	1500	1500	1450
Steam pressure, lb.	108	106.5	104.5	114	107	102	103.5	106	108	102	108	111	106	108	108	104.5	109	105	97.5	114.5	112	105	105	98	106
Vacuum, inches	26.5	26.5	26.2	26.7	26.0	26.2	25.3	26.9	26.4	26.8	26.7	27	27.3	27.2	26.9	27.0	27.1	27.6	27.1	27.6	27.0	27.1	27.7	27.4	27.8
Air pressure, lb.	37.5	36.5	35.5	36.5	35.5	44.5	45.5	44	44.5	45	56	56	56.5	57.5	57	72	72	73	71.5	71.5	71	76.5	78	78	76.5
I.H.P.	111	109	108	110	116	194	190	187	192	193	272	288	269	280	280	406	378	367	363	385	386	431	422	419	432
B.H.P.	89	84	86.5	91	93.5	161	159	166	167	171	248	250	246	252	248	344	338	336	324	338	340	389	388	385	370
Oil per hour	40.9	37	37.5	41.1	42.5	66	60.7	66.4	68.2	67.4	96	94.2	94.8	98.9	98.7	129.9	127.2	129.9	128.9	141	130.1	151.7	153.7	161	152.7
Oil per B.H.P. per hour	.459	.441	.434	.452	.454	.410	.382	.400	.408	.394	.387	.377	.385	.393	.398	.377	.377	.386	.398	.417	.383	.390	.396	.418	.412

Column No. 1 gives trial results from Lucigen shale oil.
" No. 2 " " " Anglo-American.
" No. 3 " " " Shell Mexican (S.G. 0.904).
Column No. 4 gives trial results from Shell Mexican (S.G. 0.936).
" No. 5 " " " British Mexican.

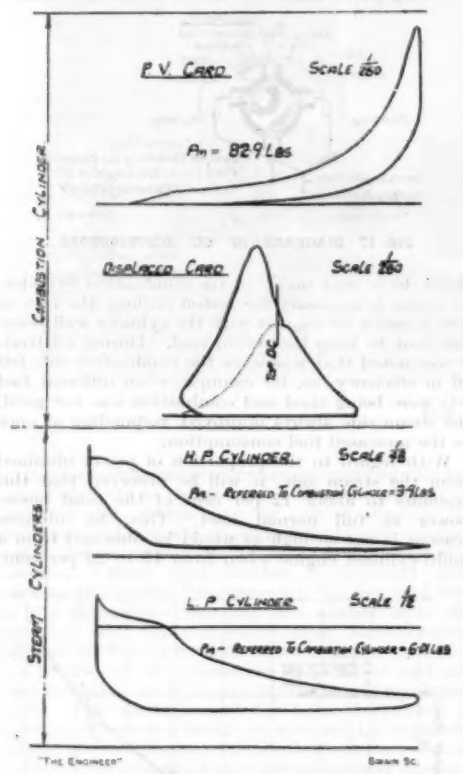


FIG. 19—TYPICAL INDICATOR DIAGRAMS

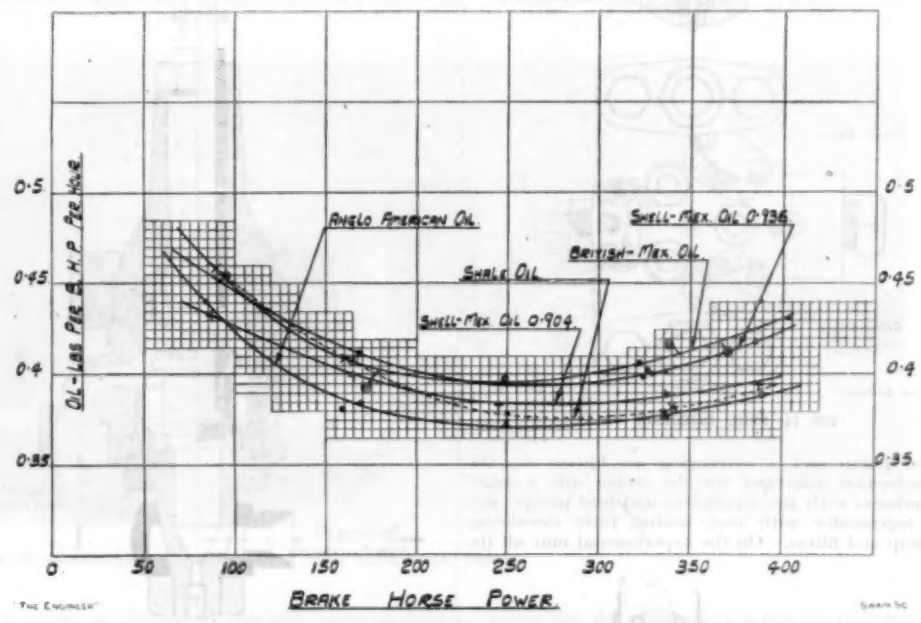


FIG. 20—CURVES OF OIL CONSUMPTIONS PER BRAKE HORSE-POWER HOUR

TABLE II.—*Particulars of Fuel Oils used in the Trials.*

	Scottish shale oil (Lucigen).	Anglo-American Diesel oil.	Shell Mexican Diesel oil.	Shell Mexican boiler oil.	British Mexican boiler oil.
Specific gravity at 60 deg. Fah.	.879	.884	.904	.936	.94
Flash point, degrees Fah.	266	198	194	188	208
Viscosity at 60 deg. Fah (Redwood No. 1)	96 sec.	71 sec.	145 sec.	—	—
Viscosity at 120 deg. Fah. (Redwood No. 1)	40 sec.	39 sec.	53 sec.	200 sec.	1380 sec.
Ash, per cent.	Trace	Trace	0.08	Trace	0.30
Sulphur content, per cent.	.36	.4	1.84	3.01	3.68
Calorific value, B.Th.U. (gross)	19,426	19,334	19,037	18,581	18,382
Calorific value, B.Th.U. (net)	18,065	17,970	18,000	17,430	17,300
Minimum temperature required for complete combustion in air, deg. Fah.	698	680	779	824	880

* See THE ENGINEER, February 3rd, 1922.

boiler or supplying added steam to the engine beyond that produced by the waste heat of the combustion side. This means that when installing an engine in a power station it can be rated at such a power as will enable it to run at maximum efficiency for twenty hours out of the twenty-four and yet carry the few hours of peak load, and that without much loss in efficiency. This characteristic, coupled with the lower fuel consumption, would seem to offer distinct advantages in the case of mixed steam and internal combustion power stations and an early development in this direction is awaited.

Institution of Electrical Engineers.

JUBILEE MEETINGS.

In commemoration of the first meeting of the Society of Telegraph Engineers, which took place on February 28th, 1872, the Institution of Electrical Engineers held a series of special meetings this week at the Institution's headquarters, at Savoy-place, Victoria Embankment. At the first of these meetings, which took place on Tuesday afternoon, Dr. J. A. Fleming delivered an extremely interesting experimental lecture on *Michael Faraday and the Foundations of Electrical Engineering*. Owing to illness, the President, Mr. J. S. Highfield, who, it seems, was the first to suggest that these commemoration meetings should be arranged, was unable to be present, and Mr. Campbell Swinton, F.R.S., took the chair.

In opening his lecture, Dr. Fleming said that electrical engineers busily engaged in practical work were apt to forget, or at any rate underestimate, the immense importance of Faraday's work, and he doubted if many had been able to find the time to read the three volumes dealing with his research work and discoveries. After describing how Faraday discovered that an electric current, acting on a magnet, would produce motion, and referring to William Sturgeon's electro-magnet which was introduced in 1825, Dr. Fleming went on to explain how Faraday made those great discoveries which formed the basis for the development of dynamo electric machinery. Knowing that an electric current would move a magnet, Faraday then began to consider whether there were any reason why the motion of a magnet should not produce an electric current; and in 1831 he succeeded in producing a current in that way. Faraday's well-known experiments in electro-magnetic induction were then carried out by the lecturer, who exhibited the original coils, electro-magnets, &c., used by Faraday at the Royal Institution.

In dealing with Faraday's famous iron ring with two insulated coils wound upon it, Dr. Fleming explained that when Faraday found that when one coil was energised or de-energised, a current was set up in the other coil he was at first at a loss to explain the phenomenon. He ultimately proved, however, that it was due to the change in the magnetism, by placing an iron bar inside a coil and by applying permanent magnets to the end of the bar. On placing the magnets on the bar, and on removing them, a current was induced in the coil and showed conclusively that the magnetism in the iron produced the current. Having shown how Faraday demonstrated that by plunging a bar magnet into a coil, or by withdrawing it, a current was induced in the coil, and having explained that Faraday found that the current depended not only upon the strength of the magnet, but also upon the speed at which it was moved, Dr. Fleming went on to deal with Faraday's large permanent and electro-magnets. With this magnet, it was explained, Faraday made his greatest discoveries. During ten days of experimental work in the laboratories of the Royal Institution in the autumn of 1831, he performed the experiments which subsequently resulted in the evolution of the dynamo. He found that if a copper disc were revolved in a magnetic field the lines of force cutting the disc would result in the establishment of an electrical pressure, and that if a galvanometer were connected between the centre and edge of the disc a steady current would flow through the instrument all the time the disc was rotated. That was really the first dynamo.

Very soon after Faraday's demonstration, others began to design various practical forms, some of which were shown, together with Faraday's original machine, during the course of the lecture. One of these machines was Pixii's dynamo, which was introduced in 1831, and was used for generating an alternating current by the rotation of a permanent magnet in front of coils, which formed the armature. Pixii's original machine was afterwards provided with a commutator which enabled it to deliver direct current instead of alternating current. Other early dynamos to which Dr. Fleming referred were those developed by Clarke, Nallet, Dr. Werner Von Siemens, Dr. Pacinotti, Gramme, Wilde, Holmes and Hopkinson. The original multiple magnet machine which was used in the South Foreland lighthouse was on view, as well as the first Parsons' turbine and various other relics. Whilst dealing with these early dynamos the lecturer referred to the important discovery made by Wilde, Siemens and Wheatstone, namely, that a dynamo with electro-magnets could be made to excite itself if the magnet coils were connected across the armature. Prior to that discovery Wilde had invented a machine having a small permanent magnet exciter which was mounted on top of the dynamo.

Among other striking experiments which Dr. Fleming showed to illustrate the work of Faraday was that of placing a coil of wire over one of the poles of a magnet, and so causing a spark to appear at the ends of the coil. That experiment, it was explained, formed the basis of the magneto. It was also shown how Faraday demonstrated that the earth itself was a powerful magnet by moving a coil connected to a galvanometer in the earth's field. Faraday was reported to have said, Dr. Fleming went on to explain, that he only once remembered a useful question being asked after he had delivered a lecture. That question was put by a Mr. Jenkins, who desired to know why it was that when a primary cell was short-circuited the person who made the short circuit did not get a shock, but when a coil of wire was connected in series with the cell a shock was felt. That, Faraday thought, was a really useful question, because at the time he had not thought about the matter, and he was unable to answer the question. He soon set to work, however, to solve the problem, by connecting a galvanometer inductance and battery in parallel, and by switching the battery out of circuit periodically by means of a key, he found that owing to the collapse of the magnetic lines within the coil the galvanometer needle gave a deflection, and that experiment served to establish the principle of self-induction.

The lecturer also had a good deal to say about Faraday's work in connection with electrostatics, electrolysis, &c. Reference was made, for instance, to Faraday's special form of Leyden jar, which was constructed in 1837, and which consisted of a metal sphere supported concentrically within a spherical metal shell. Faraday found that by filling the vacant space with air or by creating a vacuum in it the arrangement had a certain capacity for electricity which might be called unity. But if the space was fitted with any other liquid or solid insulator, such as sulphur or paraffin wax, the capacity was represented by a larger number, equivalent to the increase in capacity as compared with an air condenser and that number was called the dielectric constant or the specific inductive capacity, as Faraday termed it. Faraday also showed, Dr. Fleming remarked, that a cable immersed in water really constituted a form of Leyden jar. The work of Maxwell was also dealt with.

An experiment was made for the purpose of showing that when two pieces of copper or silver, for example, are placed in a suitable electrolyte and a current is passed through the solution from one electrode to the other, electro deposition occurs, and it was explained that Faraday showed that there is a definite relationship between the strength of the current and the amount of metal removed. In the case of silver electrodes—placed in a solution of nitrate of silver—a current of 1 ampère, it was explained, deposits .001118 gramme of silver per second. In connection with this part of the subject, Dr. Fleming referred to Edison's zinc plate house meter, as used in 1882–1885 for metering the electric energy supplied for electric lighting. Faraday's laws, Dr. Fleming said, formed the basis of all our electro-chemical industries.

The lecturer then referred to Faraday's electro-optic and magnetic work and the audience was shown the experiment designed to utilise the magnetic properties of a ray of light. The lecture was concluded with a reference to the character of Faraday as a man as well as a scientific investigator, and an appeal to the audience to support the research work of the Royal Institution. That Institution, Dr. Fleming contended, was of enormous value to the community. Sir James Dewar had stated recently that the maintenance of the Institution during the last 120 years had been little more than £100,000, which was not a twentieth part of the cost of a battleship. The discoveries of Faraday alone had put untold wealth into the exchequers of nations and had laid the firm foundations upon which present-day electrical engineering was built.

After the lecture the Chairman, Mr. Campbell Swinton, remarked that there were only two surviving members of the original Society of Telegraph Engineers, and he was pleased to say that one of those members, Sir Herbert Jekyll, was present, and he would call upon him to propose a vote of thanks. Sir Herbert said that when the Society of Telegraph Engineers was formed no one had any idea that it would develop in the manner it had done. He remembered attending the lectures of Faraday, when he (the speaker) was a boy, and although he could not remember a great deal about those lectures, one or two facts were firmly fixed in his mind. He could recall, for example, that Faraday was always very partial to boys, and frequently gave them little relics such as pieces of magnetised wire to take away with them. He lived, as most of the members were no doubt aware, at the Royal Institution, and a Mr. Murray, a Scotsman, made his experimental apparatus. Faraday was an excellent lecturer, and he never failed to attend lectures delivered by others at the Royal Institution. In seconding the proposal, Mr. C. H. Wordingham remarked that one of the most extraordinary things which Dr. Fleming had brought to light in the course of his lecture was that Faraday's greatest discoveries were made in a period of only ten days.

We cannot conclude this brief account without expressing our admiration of the lecture regarded as a performance. Experiments must have been made at intervals of less than five minutes throughout the hour or more that Dr. Fleming was speaking, but on not a single occasion was there the smallest hitch of any kind. Dr. Fleming was surrounded, practically packed in, with apparatus of all kinds, but he knew to an inch where everything was, and to a second when it would be wanted. He had suitable galvanometers and electroscopes projected on the screen, so that the effects he produced might be made visible to the whole audience. The subject matter is now elementary electricity and magnetism, and was familiar, no doubt, to nearly all his audience, but it was none the less delightful to see the experiments with which Faraday had astonished the world repeated once again, and with a success and neatness that not even the great discoverer himself could have excelled.

On Wednesday afternoon a meeting was devoted to short discourses on "Reminiscences and Experiences of Electrical Engineering in both its Technical and Legislative Aspects." The first speaker was Colonel Crompton.

Colonel Crompton said that his connection with the electrical industry dated back forty-four years, when he began serious electrical work by installing Gramme dynamos and Serrin lamps and had to go to telegraph engineers to learn the technicalities of the business, which were then very wonderful. At a meeting of the Institution of Mechanical Engineers in Paris during 1878 he was the only English mechanical engineer present who had ever worked with a dynamo. During that early period he had many amusing experiences whilst travelling round the country with portable electric apparatus. The first country house, so far as he knew, to have a regular installation of electric light was Berechurch Hall, owned by Coope, the brewer. In the year 1883 the Ring Theatre in Vienna was burned as the result of an escape of gas, and the Emperor issued an order that gas would not be allowed in any of the Imperial theatres. As a result the Vienna Gas Company decided to take up the supply of electric light, and he went over to assist in the design and erection of one of the earliest central stations on a large scale. At that time Rathenau and Deutsch used frequently to go to Vienna to watch what he was doing. This installation was the prototype of many central stations which were built during the nineties in London and various towns in England. Later Rathenau and Deutsch founded the A.E.G. of Berlin, but their early attempts at large generating machinery were, Colonel Crompton stated, positively comic. The rings of the dynamos were about 20ft. in diameter, and served as the fly-wheel of German engines, which had a smaller output than the 200 horse-power Willans engines used at Vienna, and which occupied about one-tenth of the space and were far more economical. He wanted to apply his Viennese experience to lighting various parts of London, but was unable to proceed with the work owing to the impossibility of raising capital under the Electric Lighting Act of 1882. Eventually he found that there was at the Kensington Court Estate a subway through which he could lay mains to connect up fifty or sixty houses with the central station. Thus in 1888 the Kensington Court Electric Lighting Company, the first real lighting company, was started. Lord Alverstone and Sir Frederick Bramwell were among the original and largest shareholders in this enterprise.

Sir Alexander Kennedy gave some interesting and amusing facts concerning his early experiences at the Westminster Electric Supply Company. That company, he said, originally had a number of small stations which gave rise to many complaints in the vicinities in which they were situated. Noise and vibration were alleged to be a nuisance to the inhabitants, and in one case a complaint was actually raised on the grounds that noise was produced by the current rushing through the mains. By way of indicating that the nuisances complained of were more imaginary than real, Sir Alexander mentioned that on one occasion some new machines were delivered to the Millbank station, and although those machines were merely placed in the station and not set to work, complaints of noise and vibration were immediately lodged. In another case a man living in the vicinity of a station which was said to set up vibration in the house in which he lived, was asked to say when the vibration was most pronounced, and the time he specified was when the machines were not at work. The people who lived in Mayfair were found to be particularly fussy about vibration, and the Davies-street station gave rise to a good many complaints. On one occasion a doctor complained that the current he was receiving was only giving sparks, and at first it was difficult to understand his meaning; but it was found upon investigation that the filaments of his lamps were broken and the sparks were caused by the ends of the filaments making and breaking contact. Sir Alexander also said that he could recall

many quarrels with Mr. Ferranti concerning the relative merits of alternating and direct current.

Sir Oliver Lodge said that the house which he occupied in Birmingham until two years ago was lighted by a private plant installed by one of Colonel Crompton's pupils. Some time after the plant was put down a public supply was provided, but he continued to use the engine and dynamo, which worked satisfactorily. The wiring was suitable for 40 volts, but he would not have cared to subject it to a pressure of 200 volts. The plant was looked after by a gardener, who on one occasion made the important discovery that the engine would work without the ignition switch being turned on. Investigation showed, however, that the engine was not really working at all, but that the set was being motored round by current drawn from the battery. In the early days there were no electrical units, and it was customary to take 70 yards of bell wire as a resistance standard. Referring to the current unit, the ampère, coming into use, Sir Oliver Lodge said he remembered a workman referring to it as a "hamper" of electricity. Some rather exciting things occasionally happened in the early days on the Bushmills electric railway, which was provided with a live rail a foot above the ground. The line, if he remembered rightly, was worked at 500 volts, and shocks received from it were not pleasant. On one occasion a cow came into contact with the rail and was killed. Lord Kelvin could, however, touch the rail with impunity, owing, apparently, to the exceptionally high resistance of his skin. Finally, Sir Oliver Lodge referred to very important work done by Mr. Heaviside, who, he said, was a genius of an exceptional kind. It was not perhaps known to many members of the Institution that Mr. Heaviside was in a very poor state of health, and he would like to suggest that in view of the commemoration meetings and the very important work which Mr. Heaviside had done, a message of sympathy should be sent to him. Dr. Eccles said, however, that Mr. Heaviside's case was already receiving the attention of the Council, and that he had been communicated with.

The disastrous effect of Chamberlain's Electric Lighting Act was referred to by Mr. E. Garcke, who showed that we owe the reactionary Electric Lighting Acts, like the Tramways Act, 1870, on which they were modelled, to the spirit of the times. After the Napoleonic wars there was an immense extension of public utilities under private enterprise; and the swing of the pendulum in the latter half of the century brought in a movement towards State and municipal control, and eventually ownership, of public services. The Act of 1882 was described by Mr. Garcke as "premature, pretentious, pernicious." Mr. Garcke concluded by appealing for still more co-operation within the industry and for better correlation between scientific research and philosophic generalisation.

Mr. Sydney Evershed's reminiscences went back to the days when even the Atlantic telegraph was a novelty. He recalled how his father used to read out at the breakfast table each morning the messages sent from the ship engaged on laying the first cable across the ocean. What impressed itself on the mind of a child, he said, was the fact that the men out there in the middle of the ocean were sending a message back to England through the Atlantic cable. Even more vivid was the effect of the first telephone.

As for electric light, Mr. Evershed gave the quiet little town of Godalming the credit of being a pioneer. In 1881 he found the streets of Godalming lit by Swan incandescent lamps and by arc lamps which "flooded the sky with a blaze of glory." Electricity for this early installation was produced by water power, and the cables were "laid in the gutter with nothing to protect them from the wheels of carts or the hoofs of cart horses."

Later it became compulsory to put electric cables underground; and out of that necessity Chamberlain's notorious Electric Lighting Act was passed, and the newly born industry was handicapped for the space of six years—that is to say, until the Amending Electric Lighting Act of 1888 was passed.

Mr. A. H. Walton said that a single-phase electric lighting installation was put down by Mr. J. E. H. Gordon at Paddington railway station in the early 'eighties.

The Gordon system of electric lighting was installed over the area between Paddington Station and Westbourne Park of the Great Western Railway, and the work was undertaken by the Telegraph Construction and Maintenance Company of East Greenwich to test the practicability of central station lighting. The district was 1¼ miles long and covered some 67 acres. Sir Daniel Gooch was at that time chairman of the Telegraph Construction and Maintenance Company, and also chairman of the Great Western Railway. The design of the 8ft. Gordon machine was commenced early in 1884, after much experimental work had been carried out at Enderby's Wharf, East Greenwich. The output of each machine was to be 400 kilowatts at 150 volts. Each machine was directly coupled to a vertical engine built by J. and J. Rennie. The field or rotating part of the dynamo weighed some 22 tons, and consisted of fifty-six drum type coils, twenty-six being mounted on each side of a wrought iron disc or wheel. The alternator had its coils separated out into two circuits, called "red" and "blue," an arrangement which in reality was nothing more or less than what was now known as a two-phase scheme.

In the Great Western offices and hotel, 4115 incandescent lamps, each of 25 candle-power, were installed. In the passenger and goods station and various yards 98 arc lamps, each of 3500 candle-power, were in use. In addition, two arc lamps were erected at the front corners of the Great Western Hotel of some 12,000 candle-power. At the time this work was started the difficulty was to find a suitable alternating current arc lamp, and after much experimenting at the Greenwich Works, alterations were made to the Crompton direct-current lamp.

The plant was started up towards the end of 1885, when it was found that the generators took more power to drive them with the main switch open than when on load, in consequence of the inductive effect in the machine. The temperature of the stator coils also rose to a very high figure in spite of water circulation. The plant was therefore shut down and the stator coils taken out, unwound and the cores slotted, it being Mr. Gordon's opinion that that would materially reduce the working temperature. After slotting the cores along their length and re-winding, the cores were replaced. The hollow bolts securing the cores to the frame of the machine were filled up and water circulation around the frame of the machine was relied upon. With those alterations, a slight improvement on temperature was made, but the temperature was still so high that frequent re-winding of coils was necessary. Mr. Gordon was urged to substitute laminated cores, but he was so satisfied that solid cores were correct that matters were allowed to remain. A considerable amount of trouble was experienced from inductive effects, also from the breakdown of the Gordon divided mains or feeders, which were insulated with gutta-percha. These mains were laid underground in the 6ft. way, and it was some considerable time before the cause of the trouble was recognised to be due to the small tank locomotives used for shunting purposes, which stood for some considerable time at one spot with their boiler feed injectors dropping hot water, which percolated through the ballast on to the feeders and caused them to become a solid mass. The three years' running of the contract commenced on April 31st, 1886, and during the early months of that period the engineers had an anxious time. However, after twelve months' working the Great Western Railway took over the plant. During the carrying out of the work it involved considerable sacrifice to all concerned to obtain success, for it was a rare occasion indeed when the staff did less than twelve to fifteen hours per day during the experimental running period. Fortunately, they were left alone to do their work without interference from outside sources, their one great object being to attain success. Soon after the Great Western Railway took over the plant, Mr. Walton said, he set to work and got a few laminated cores built of the softest iron he could obtain at the Swindon Works. A very marked improvement was made in the temperature rise and resultant efficiency of the plant. This old and historic plant had been replaced, but it should, he thought, certainly retain a place in the pioneering of electric lighting in this country.

Fifty years of submarine telegraphy—1869 to 1919—were reviewed by Mr. Walter Judd, who was intimately connected with this field over the whole of the period. In 1869, he said, there were three Atlantic cables and no others: in 1919 there were 305,000 miles of submarine cable. So well were the foundations of this industry laid by British engineers and men of science, that the cables of to-day are of the same general type as in 1866. First with the mirror galvanometer and later with the siphon recorder, Lord Kelvin solved the problem of operating submarine cables; and both instruments were practically unaltered at the present day. The first great change in cable operation was the introduction of duplex working by which messages could be sent simultaneously from both ends of the cable. Only those who were present at the first landing of a cable to connect outlying communities to their countries, Mr. Judd said, could have any idea of the excitement and pleasure produced. He mentioned how the laying of a cable opened up new streams of commerce and stimulated the development of distant countries. Mr. Judd was convinced that submarine telegraphy would continue to bear its great part in social, political, and commercial advancement.

THE ANNUAL DINNER.

On Tuesday evening the Institution's annual dinner was held at the Hotel Cecil, when the Vice-president, Dr. Eccles, F.R.S., took the chair. After a message of sympathy had been sent to Mr. J. S. Highfield, who, as previously stated, is at present unfortunately unable to take any part in the Institution's activities on account of illness, the Chairman announced that his Royal Highness the Duke of York, who was invited to be the Institution's principal guest, had sent a message saying that he greatly regretted that he was unable to attend the dinner, but he desired to express to the President and members of the Institution his best wishes for a successful commemoration dinner, and hoped that the Institution would continue to prosper and render the same yeoman service in the future as it had done in the past for the benefit and advancement of science, commerce, and industry of this country. Greetings were sent from the American Institute of Electrical Engineers, the French Society of Electricians, the Dutch Royal Institute of Engineers, the Association of Managers of Dutch Electricity Undertakings, Mr. Thomas A. Edison, Sir John Snell, the chairman of the Electricity Commission, and last, but not least, from the Institution of Gas Engineers. In proposing the toast "The Institution of Electrical Engineers," the Postmaster-General, the Right Hon. F. G. Kellaway, P.C., called attention to the rapid development of the Institution, which was originally composed of a body of about 100 men, who called themselves the Society of Telegraph Engineers. During a period of fifty years they had seen the science and art of their industry make the most wonderful developments in the whole history of human endeavour. At the present time the Institution had 10,000 members. It had also acquired a Royal Charter, and the honour of having his Majesty the King as Patron. In replying to the toast, Dr. Eccles pointed out that, apart from the fact that the dinner commemorated the fiftieth anniversary of the first meeting of the Society of Telegraph Engineers, it was the first dinner that had been held since the Royal Charter was granted and since the King had become the Institution's Patron. The toast of "Our Guests" was proposed by Mr. Ll. B. Atkinson, and was responded to by Sir H. M. Trenchard, Bart., K.C.B., D.S.O., Chief of the Air Staff, and the Hon. Mr. Justice Sargant, Judge of the High Courts.

NEW PORT WORKS IN ITALY.

Owing to its geographical importance, the port of Naples, which enjoys a trade exceeding an annual value of £9,000,000 and a thriving industry in shipbuilding, a large amount of capital is being devoted to the completion of the port improvements which had been commenced before the war, but, owing to its exigencies, indefinitely suspended. The result has been an intense congestion, which has now arrived at such an acute stage that the authorities can no longer disregard the earnest appeal of Southern Italian shipping interests to proceed with the suspended operations.

Naples is a port of embarkation for emigrants, and the lack of sufficient accommodation has seriously interfered with the progress of the steady stream of overseas settlers desirous of leaving Italian shores since the conclusion of the war. The port improvements at Naples which the Government has already taken in hand, and upon which further operations have now been started, are of prime importance; but, apart from the works which will be carried out at the expense of the State, preliminary plans for three large projects have been submitted. If approved, as seems probable, they will be carried out by private capital. The first of the contemplated schemes comprises the construction of three large piers from the present Molo San Gennaro, to be equipped as a goods and passenger terminus, affording easy access to the hotel section of the city, which is, just now, undergoing considerable extension. According to the plans submitted, the piers will have a complete railway connection, mostly subterranean, the latter being considered an essential improvement in view of the congested condition of the main streets of Naples. A novelty will be the connection of the subterranean railway by means of special stations leading or giving access to the hotel section by means of a new street. The latter undertaking will be the concern of the State in connection with various municipal governments interests, the total cost being placed at 40,000,000 lire (nominally £1,600,000). The cost of the piers and warehouses will be in addition, and approaches 65,000,000 lire (nominally £2,600,000). Two leading Italian steamship companies have agreed to finance the construction of two of the piers, but the Government has, so far, declined to grant a concession until the entire project is assured.

The second scheme contemplates the widening of the present Molo Orientale by 50 m., and the construction of six additional warehouses with a total floor space of 28,800 square metres. The pier will be centrally situated close to the industrial and wholesale section of the city, the total cost of construction being estimated at 40,000,000 lire. The third project comprises the installation of a complete oil depôt, equipped with a heating and pumping plant and having a capacity of 190,000 barrels. Through pipe-lines, fuel oil will be supplied to industrial plants situated in the free-port zone. This undertaking will be financed by an Italian oil corporation, which will work the scheme on the warehouses basis. So far, the capital for this undertaking has not been arranged.

The railway regulations as to labelling goods provide that labels or tallies, giving the name and address of the consignee or a distinguishing mark shall be fastened to articles or packages, or, in the case of metal bars, &c., painted or stencilled on the article. On February 13th the following traffic was for the present made exempt from these regulations:—(*a*) Returned empties when branded with the owner's name and address; (*b*) any general merchandise of the same or similar description carried in consignments of 1 ton or upwards to the same consignee, necessitating the exclusive use of a wagon, instead of 2 tons and upwards as formerly; (*c*) articles or packages of precisely the same size, description and quality in consignments of 2 tons and upwards from the same sender, for one destination station, for two or more consignees; (*d*) export and import goods conveyed in through trucks direct to ships and *vice versâ*.

A Seven-Day Journal.

London University Site.

AN agitation for reconsideration of the site for the new buildings of London University has been revived by the London County Council, whose interest in connection with the extension scheme is on the financial side. The Education Committee of the Council, at its last meeting, recommended that the possibilities of the Holland Park site, in preference to that at Bloomsbury, should be again considered. The old and familiar argument that the Holland Park site is larger and could be acquired at less cost than that provisionally selected was again brought forward, and it was decided to press the subject on the attention of the Board of Education. It will appear to most people that, apart from the respective advantages of the two sites, about which there are sharp differences of opinion, the Senate of the University is already committed to the Bloomsbury scheme, and that the question is unlikely to be reopened.

Students in Hydro-electrics.

THE comment made in the first interim report of the Water Power Resources Committee regarding the lack of training facilities in the universities and technical colleges for young engineers wishing to enter the field of hydro-electric development has attracted the attention of the Edinburgh Chamber of Commerce. The whole subject has indeed been considered by the directors of that body, and as Scotland is particularly interested in hydro-electric developments the recommendations made with the object of obtaining the necessary educational facilities will doubtless receive careful consideration. It is hoped that Edinburgh University may become a centre of training in hydro-electric engineering, and this expectation is partly at least based on the fact that good facilities for technical teaching in hydraulic engineering already exist at the university. For this reason it is believed that it would be a sounder policy to develop existing departments in engineering rather than found a new chair for hydro-electrics. This should not be difficult, as the Engineering Department is to be transferred to new buildings on the site recently acquired at Liberton. A Government grant would be necessary to provide for salaries of lecturers and for additional special apparatus and plant, but the sum required would be small in comparison with that which would be involved in the establishment of an entirely new chair. The views of the university authorities, the Minister of Education, the Board of Trade, and the Secretary for Scotland, all of whom have been approched on the subject, have not yet been disclosed.

Non-ferrous Metals Research.

INVESTIGATIONS which are likely to yield important results are outlined in the second annual report of the British Non-Ferrous Metals Research Association. They include a research on brass casting, and on the influence of impurities on the working properties of copper, the latter being conducted at the National Physical Laboratory by Dr. W. Rosenhain. Investigations of more general interest to engineering firms are those on metal polishing and grinding and on the jointing of metals. The electric melting of non-ferrous metals is also receiving attention. Another important work is that on the atmospheric corrosion of metals, which is of particular interest to the non-ferrous metals industry owing to the production of rustless steel and iron. The study of the initial stage of corrosion exemplified by tarnishing and loss of reflection from polished surfaces is already yielding interesting results.

Labour and Costs of Production.

As a contribution to the problem of the moment, the report of the Production Cost Sub-committee of the Trade Depression Committee of the Federation of British Industries merits more attention than it has yet received. It will be said, perhaps, that the facts to which attention is directed in the report are familiar to all who have given even cursory attention to the subject, but it was necessary that the burden of high wages costs in production should be discussed with the authority which must attach to any report issued by a great industrial organisation. It cannot be denied that by far the greatest element in cost of production is the wage cost, since in this must be included not only the direct wage cost, but the wages involved in the production of fuel, power, materials and machinery, and in transport. In order, therefore, to secure a substantial reduction in prices, a substantial reduction in wage costs must be effected. This can be done in two ways: either by reducing the rates of wages or by the workpeople giving a greater output for the wages which they receive. In many industries the necessity of reducing wage costs has been frankly recognised. On the other hand, certain arguments have been advanced against such a policy, which, although fallacious, have had a certain effect upon the minds of workpeople. The chief of these is that a reduction in the rate of wages means a reduction of purchasing power, and consequently an intensification of the trade depression, whereas the continuance of high wages would maintain in circulation a large volume of purchasing power. This statement is only true provided that employment can be maintained. Any attempt to maintain the existing level of wages when the prices obtainable from abroad are insufficient must therefore result in unemployment, a reduction of the total amount of wages paid, and therefore in the volume of purchasing power in circulation.

Safety Fuel Tank Competition.

FINAL tests of the survivors of the elimination tests of tanks for aircraft in the Air Ministry Competition took place this week. The trials consisted of acceleration and crashing and firing tests. The three types of tanks which emerged successfully from the earlier trials are the Boothby gas armoured tank, the Imber self-sealing tank, and that submitted by the India Rubber and Gutta Percha Company. The crashing tests were similar to those in the earlier trials, but special tests were devised to determine the resistance to acceleration. In the firing tests the tanks were subjected to machine gun fire with ammunition capable of penetrating the ordinary type of mild steel fuel tank and of exploding and igniting the fuel either on contact or after penetration. The results will be promulgated in due course.

Russian Professors Strike.

THE unusual occurrence of professors going on strike is reported in connection with the University of Moscow. The decision of the teaching staff, who, it should be noted, have the entire sympathy of the students in their action to discontinue their classes, is due to the simple fact that the professors have received no salary for some months past. It is hoped that this almost unprecedented action will bring the authorities to reason.

Railwaymen's Hours and Wages.

As was anticipated, following the decision in the case of Scottish railwaymen, English and Welsh railway companies have decided to apply to the Central Wages Board for an extension to their workers of the conditions of the Scottish award. It was hoped that it might have been possible to settle the matter by negotiations, but the National Union of Railwaymen, which was approached in the matter, raised questions concerning certain grades of employers with whom a settlement under the original award had not been effected. The Union's request that a decision concerning these grades should be made before discussing the general application of the recent award would have involved a great deal of delay, and it is for this reason that it has been decided to bring the matter at once before the Central Wages Board.

St. Lawrence Development Scheme.

OPPOSITION to the plans for the joint development of the St. Lawrence navigation above Montreal by the United States and Canada increases. The Quebec Government has raised objection to the project on the grounds, it is believed, that the opening up of the Great Lakes to ocean traffic by the St. Lawrence route would be in the commercial interest of the United States rather than Canada. There is also hostility to international control of the waterways and the electric power plants which would be developed if the scheme should be carried out.

Air Transport Freight Rates.

COMPLAINT was made at the Air Conference of the very small tonnage of goods carried by the existing air lines. One explanation is the comparatively high rates which have hitherto been charged for air transport of goods, and the experiment which is being made by the Handley Page interests with lower rates on the London-Paris route with a minimum of 5d. per pound and special terms for large consignments will be watched with considerable interest. The new rates are approximately from 50 to 60 per cent. lower than those charged under the old tariff. The rates quoted include collection within the London suburban area and delivery in Paris, and the intention is that parcels collected in London in the morning shall be delivered in Paris the same evening. It is recognised, of course, that a comparatively short route like that between London and Paris does not bring out the advantages of air transport for parcels traffic, but if, as Mr. Handley Page suggests, it is possible to link up the service with that for India *vid* Marseilles, it seems probable that a good deal of traffic would be secured. It seems almost incredible that the cross-Channel services to France, Belgium and Holland during the first nine months of last year carried less than 200 tons of goods, but these figures, which were quoted by Colonel Armstrong, the President of the Federation of British Industries, at the Air Conference, were not challenged, so they may be assumed to be correct.

The Airship Disaster.

RECALLING the tragic end of the R 38, the disaster to the American-owned, Italian-built dirigible Roma has raised the question of airship design and construction in an acute form, and there will, as in the case of the accident to the British airship, be a searching inquiry into the precise cause of the disaster. The first report suggests that the wrecking of the Rome was the result of a broken or defective rudder, but this can only be determined after investigation. The loss of life would in all probability have been small, but for the fact that contact with the high-tension electric cables ignited the hydrogen with which the ship was inflated. In earlier tests helium had been employed, and it was the desire to conserve the very limited supplies of this gas which led to the substitution of hydrogen on this flight. In spite of the outcry in the American Press against the employment of the airship, it is recognised that experiments with lighter-than-air machines must continue.

Shipbuilding Wages.

GRAVE fears are entertained that the ballot which is being taken of the shipbuilding unions on the proposals of employers to discontinue the war bonus will disclose a hostile vote. As employers have intimated that in any event a cut of 16s. 6d. in the war bonus of 26s. 6d. per week will be made on March 15th, a complete stoppage of work in the shipbuilding industry is apparently in prospect. If this should be the result of the ballot now being taken a strike or lock-out, which would constitute a national disaster, will take place during the next few weeks, as the effects will be felt beyond the confines of the shipbuilding industry, which draws upon a larger number of trades than any other industry. The case for a reduction of the wages percentage on shipbuilding costs is irresistible. New orders are, owing to the concurrence of high shipbuilding costs, with unprecedented depression in the shipping industry, almost impossible to obtain, and the percentage of the total capacity of British yards now occupied with work is becoming smaller each month. The last statistics issued by Lloyd's Register showed that only 28 per cent. of the building berths are occupied by ships upon which work is in progress. During the December quarter of last year only 54,700 tons of new ships were laid down, as compared with over 600,000 tons for the corresponding quarter fo the preceding year.

Closing of Elswick Shops.

THE decision to suspend operations at the Elswick steel works and forge and stamping departments of Armstrong, Whitworth and Co., Limited, is one of the direst effects on the engineering industry of high costs of production. No new contracts can be obtained on the basis of the selling prices which must be charged, and as it would be impossible to keep the shops open except at a loss, which cannot be contemplated, there was no alternative to the closing of them down. A revival in shipbuilding cannot be looked for in the near future, even if the threatened stoppage should be averted, and the general depression in shipbuilding and other manufacturing industries has reduced the demand on steelmakers to a level which has not often been touched in past years. The extraordinary thing is that in any branch of the engineering industries union leaders should be giving the men advice to resist wage cuts, which by any method of reasoning can be shown to be inevitable. The memorandum issued by the Federation of British Industries on wages and production costs has evidently not reached those to whom the sound arguments contained in it should make the most appeal.

Hansa Canal.

INTEREST has been aroused by the announcement that plans are in a forward state for the construction by a German group of a canal to give waterways communication between the industrial districts of the Rhine and Westphalia, and Bremen, Hamburg, and Lubeck. The idea is that the canal would be constructed in section by local undertakings, and that these would be amalgamated at a later date into the Hansa Canal Company. It is reported that a Hamburg company is in course of formation by a committee, the membership of which includes Hugo Stinnes. The chairman of the Hamburg Chamber of Commerce has expressed the opinion that the proposed waterway would not only provide the shortest means of communication between the districts named, but could be constructed at a cost which would enable transport rates to be fixed at a level 50 per cent. below railway rates on the same route.

A Bradford Engineering Works.

ALTHOUGH the West Riding of Yorkshire is chiefly celebrated as the home of the heavy woollen industry, engineering has for many years played a very conspicuous part in the lives of the inhabitants of the many large towns in this area, such for instance as Leeds, Bradford, Halifax and Huddersfield, all of which are well known for their engineering works. Mention of Bradford calls to mind the names of Cole and Marchent, engineers, who were responsible for establishing the Prospect Foundry. That was in the year 1848, when it appears that two brothers, John and James Cole, together with William Marchent, all of whom were trained at the Bowling Ironworks, decided to set up in business on their own account. The buildings in which their undertaking was carried on were, at that time, of very limited dimensions, and the chief products were cast iron gearing, millwrighting work, pit-head wheels, small engines with slide and grid type valves and general repairs. To these was subsequently added the production of hydraulic plant for oil and cake mills. These principals carried on the works for a number of years, and on their retirement were succeeded by Messrs. Charles and George Cole, sons of John and James Cole respectively. The class of work remained much the same, but the business made rapid strides, especially in connection with the production of cast iron gearing and millwrighting work. About the year 1889 Mr. Herbert W. Morley entered the firm and subsequently took over the business entirely, the firm assuming the title of Cole, Marchent and Morley. From that time onwards the business continued to expand and larger works and plant of greater capacity became necessary. The firm about this time took up the building of large Corliss steam engines for mills and built units of from 300 to 1000 horse-power each, some of which are still running in the mills to-day. In 1893 the firm commenced to build more powerful engines of the same type for electric power generation, the first two pairs being supplied to the City and South London Electric Railway, which were followed by many others at Portsmouth, Southampton, Preston, Bradford and Auckland, New Zealand. At about the same period, Messrs. Cole, Marchant and Morley interested themselves in condensing plants, and this branch developed quickly.

In the year 1899 the expansion of the business called for further extensions of the buildings and plant which necessitated additional capital, and the firm was converted into a private limited liability company with the present title.

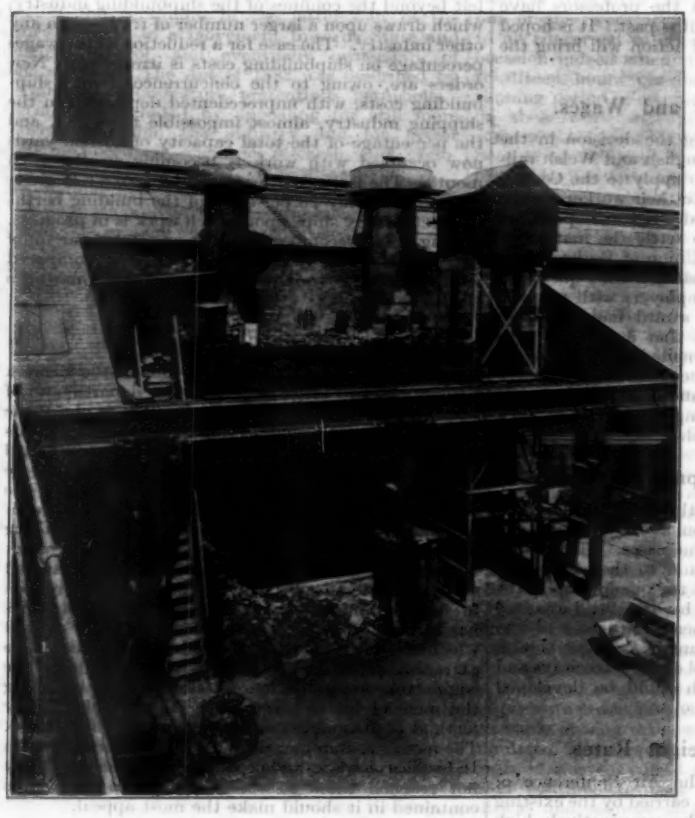
With the introduction of superheated steam for power puropoes the drop-valve type of engine commenced to supersede the Corliss engines, and one of the first large engines of the former pattern was built by the firm for a textile mill in Belfast. This engine was tested by Mr. Michael Longridge, who declared that for steam economy it established a world's record. Gold and diamond mining plant was also a speciality of the firm about the same time, winding and hauling engines and washing and screening apparatus being supplied to the leading mines in South Africa.

In 1911 the firm took up the building of uniflow engines, successful examples of which are now in operation both at home and abroad. The foundry had in the meantime become inadequate and the premises of Thornton and Crebbin were taken over. In addition to the above specialities Messrs. Cole, Marchent and Morley have since taken up the building of Diesel engines of the Morley-Guldner type, and the Spencer-Dawson tramway brake, which has been already described in these pages.

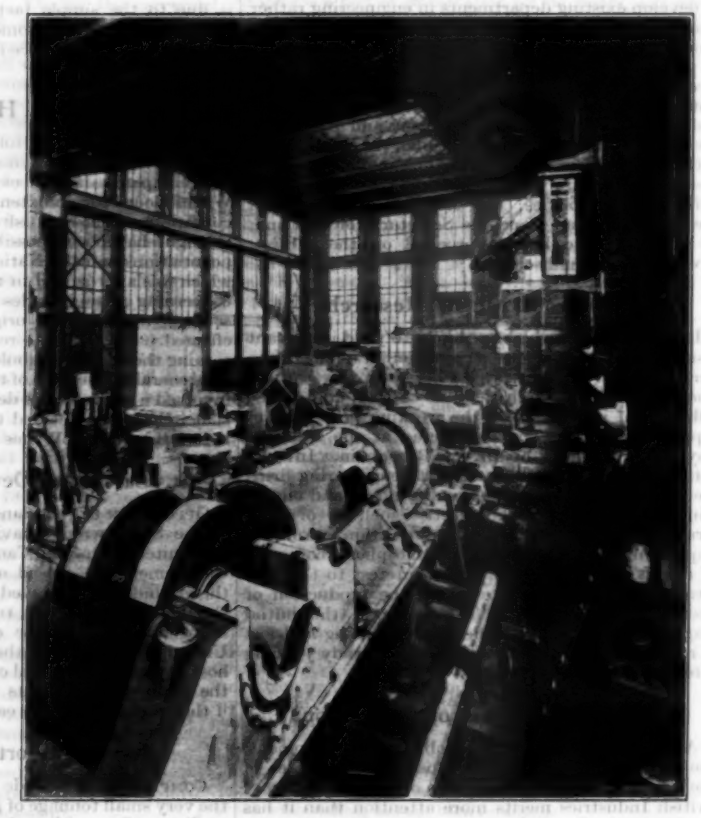
During more recent years the works have been brought into line with modern requirements in all essential respects. The equipment includes the most recent appliances intended to expedite and cheapen production, while the comfort of the firm's employees has been considered. We give on page 214 and herewith a number of views of the interior of the Prospect Works, which we have recently had an opportunity of inspecting. Commencing with the general office on the ground floor we noted the modern filing systems, Burrough's adding machines, a Remington accounting machine, and dictaphones in each of the departments. The drawing-office, which is over the general office,

THE CANTEEN

THE DRAWING OFFICE

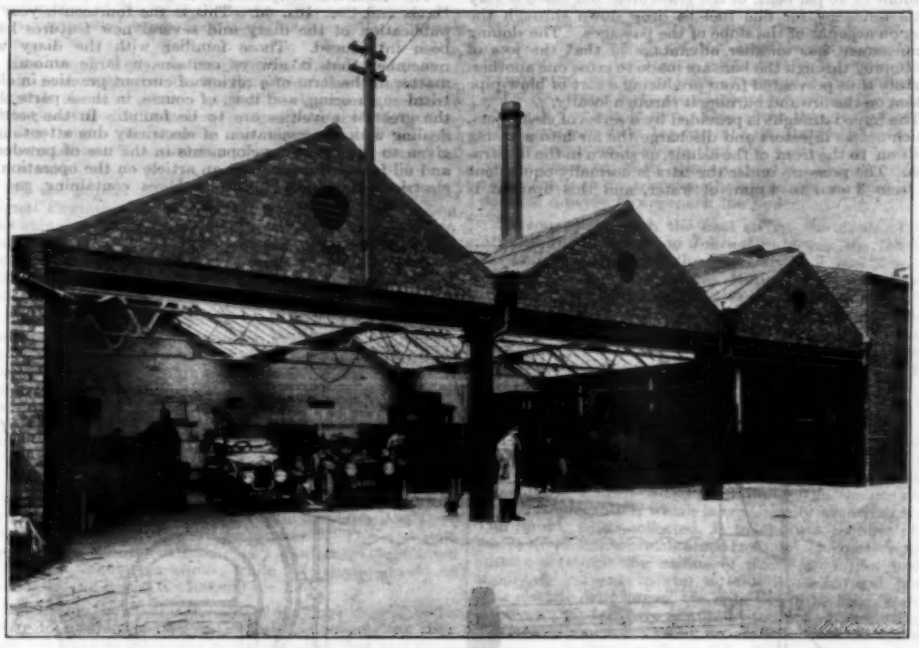


FOUNDRY CUPOLAS



VIEW IN THE ERECTING SHOP

measures 75ft. by 40ft., and there is room for about twelve draughtsmen and four tracers, besides those employed in the estimating and progress work. The equipment of the drawing-office includes a Hewittic Company's blue printing machine, washing and drying machines. Next to the drawing-office and on the same floor is a room in which there is a printing equipment which consists of a Gammeter multigraph printing machine, guillotine, pinning machine and a ticket punching machine. Practically all the works' printing is done in this department by one girl, the only exceptions being sheets larger than foolscap, ruled ledger sheets and the highest class of



MOTOR GARAGE

catalogue work. This small department has effected a very great saving in the cost of the firm's printing.

Adjoining the offices is the canteen for both the office staff and the workmen. It consists of a building 64ft. by 40ft. with a small separate room for the staff. The kitchen is well-equipped with steam and gas-heated cooking appliances, wash-up arrangements and spacious stores. From the canteen we were conducted through the stores, a capacious building 90ft. by 40ft., divided into two main sections, one containing supplies for the whole of the works and stock parts for engines and machinery manufactured by the firm, and the other for storing bars and tubing. The bars are stacked in vertical and the tubes in horizontal stacks. Bins, cupboards and drawers suitable for the various items from a $^1/_{16}$in. split pin to valve gear parts are provided. At the entrance are lock-up bins for various metal borings and scrap, and at the opposite end special tanks, fitted with hand pumps, for storing oil. In the bar store is installed a 10-cwt. travelling crane, and a 1-ton runway for bringing material in through the entrance. The necessary cutting-off machines are also provided. The whole system of keeping stores stock is carried out by means of a simple and accurate card system.

Main Machine Shop.

From the stores we pass to the main machine shop, a view of which is given on page 214. This stone building measures 215ft. by 50ft., it has large windows and ample roof lights, giving a general appearance of lightness and airiness. The shop is served by a 15-ton overhead travelling crane which traverses the whole length of the building and delivers finished products into the erecting shop at the far end. The shop consists of two bays, one down the centre for heavy tools and one at the side for medium tools. Above the medium bay is a gallery in which repetition and small work is carried out. The larger tools are arranged in groups to facilitate the handling of material, which, after coming in at the main door, passes first to the marking-off table and then to the stations for the various machines, starting with the larger boring machines and passing on to slotting machines, smaller boring machines and finally drilling machines, until the completed part is delivered to the erecting shop. The principal machine tools which call for notice are the following:—Three "Asquith" drills with 6ft., 7ft. and 8ft. arms, the latter being a special condenser tube plate drilling machine; four "Pearn-Richards" boring machines, for boring, facing, milling, drilling and tapping at one setting: in addition there is a large fly-wheel pit lathe capable of turning a 30ft. fly-wheel. There is also a fly-wheel face plate lathe, capable of taking an 18ft. wheel. Besides these there are two large boring machines for cylinders, bed-plates, &c., and a 10ft. by 10ft. by 20ft. "Buckton" planer with an electric Lancashire drive, and a large "Lang" lathe capable of turning a piston-rod 26ft. long. This lathe has four tool boxes which can operate simultaneously. Amongst the smaller machines are planers, slotting and milling machines, and Herbert No. 8 vertical millers. In the gallery we noticed an Acme automatic machine which is employed solely on the manufacture of condenser ferrules. There are also capstan and turret lathes, and other tools for repetition work.

Tool Room and Heat Treatment Plant.

The tool room is a triangular-shaped building adjoining the machine shop. It comprises three sections, namely the tool room, tool store and heat treatment plant. In addition to the usual equipment of lathes, grinders, shapers, &c., there is an Armstrong, Whitworth 6ft. measuring machine, a plate gauge and thread-measuring machine made by Baker, and a scleroscope for hardness testing. Everything in connection with the tool room is done according to system, card indexes being used for records of the jigs and gauges in use, as well as for records of repairs to machines employed in the works. The tool store is also well organised, a double check system being used for the purpose of finding and keeping count of tools jigs and gauges. The heat treatment

VIEW IN THE ERECTING SHOP

plant consists of two Richmond hardening furnaces, a hardening furnace by Wrights, a pre-heater by Herberts, and a Cambridge pyrometer for high temperature measurements.

Erecting Shop.

The erecting shop is a commodious building measuring 150ft. by 50ft. It is traversed by a 25-ton overhead crane and for handling lighter objects up to 30 cwt. jib cranes with electrical control gear are provided. At the time of our visit there were in course of erection two 500 to 625 indicated horse-power central exhaust steam engines for Courtauld's Limited. The cylinder dimensions of these engines are 26in. diameter by 27in. stroke. They are designed to develop their full power at 150 revolutions per minute with steam at 180 lb. per square inch and 550 deg. Fah. temperature. Each of the above engines will have a surface condensing plant with a cooling surface of 550 square feet. Each engine will drive a 325-kilowatt alternator coupled direct to the crank shaft.

Another order in course of erection was a vertical surface condensing plant for a 12,000-kilowatt turbine for the Leeds Corporation Electricity Works. This plant has a cooling surface of 46,000 square feet, and is intended to deal with 220,000 lb. of steam per hour with a vacuum of 28½in. The condenser, which is of special design, is of the vertical type and has a deep open box at the top for the circulating water inlet and outlet. Gates or dividing plates are provided to enable the water to be circulated through the tubes twice if desired. The base of the condenser forms a box and settling chamber with a branch arranged on one side for the admission of the circulating water to allow the flow of water to be reversed if necessary. The air extraction equipment consists of three sets of steam jet air extractors made by this firm, and the extraction pump is of the multi-impeller centrifugal type.

A special feature of the erecting shop is the provision of jacks for quick erection of the work. The firm makes a practice of running and setting all valve gears before they leave the shop, and records are kept of the performances of all engines. Recently exhaustive tests have been carried out with piston drop valves and an innovation has been introduced in the shape of an arrangement which closes the valve positively. A good deal of experimental work has also been carried out on combined exhaust, drain and relief valves and steam jet air extractors.

Smiths' Shop.

Adjoining the erecting shop is a smiths' shop fitted with a 30-cwt. steam hammer and an automatic bolt hammer. There are four hearths and each smith controls his own blast by means of an independent motor-driven fan. Forgings are made in this shop up to 3 tons weight.

Unit Assembly Shop.

The firm has recently converted what was formerly a foundry into a unit assembly shop. This shop is specially adapted and equipped for the assembly of the smaller machinery, such as barring engines, tramway brakes, air-pumps, steam jets, governors and valve gears. The shop also contains a stores for both rough and finished goods.

Pattern and Joiners' Shops.

The pattern shop measures 60ft. by 40ft., and contains a number of machines, such as Oliver's sand papering machines, a dimension saw, a Sagar's straightening and thicknessing machine, a La Rivite patented round cutter, and a band saw. There are eleven benches, each of which is fitted with an Oliver's universal tilting vice. A 10 horse-power electric motor provides the necessary power for driving the machinery. The pattern stores are arranged in an orderly manner to enable patterns to be quickly found when required. With this object each pattern is numbered and lettered.

Garage.

One of the most recent additions to the firm's equipment is a garage to accommodate its fleet of motor vehicles. This building measures 60ft. by 46ft., and has a saw tooth roof supported solely at each end, no pillars to interfere with the free movement of the vehicles being provided. The garage is

capable of accommodating nine lorries and is fitted up with the Bowser petrol measuring apparatus, including a large petrol storage tank situated below the floor. The place is illuminated by electricity and has a charging plant for accumulators. There is also a fitters' bench and an equipment of tools for repair work and steel storage bins which contain a complete set of spare parts for each lorry.

WELFARE.

The welfare side of the firm's activities has received a considerable amount of thought, and in addition to the canteen above referred to, up-to-date lavatory accommodation with hot and cold water is provided. The heating throughout the works is effected on the Stanlock hot air system, and drinking fountains are provided in every shop.

FOUNDRY.

The foundry department which is at Hammerton-street, is capable of turning out castings from a few pounds up to 40 tons in weight, and is equipped with the most modern appliances. On entering the yard there is a 50-ton weighbridge by Averys for weighing trucks direct from the railway siding; the lines are laid to the various shops, bends being obviated by means of turntables. A 10-ton electric crane traverses the whole length of the yard, but is only utilised for lifting moulding boxes, &c., the castings being delivered direct from the foundry to the trucks. Pig iron is stored in bins according to analysis. The two main cupolas of 5 and 9 tons capacity respectively are situated in the yard and are fed by means of an electric hoist with staging. Two Jackman fans, each driven by a 40 horse-power motor, provide the air blast. Recently an elevator with an iron separator, sand bin and chute has been provided for handling the sand which has been taken away from the castings in fettling—an arrangement which simplifies handling and cartage. The main foundry measures 260ft. by 42ft., and is traversed by two 25-ton four-motor electric cranes by Arrols of Glasgow. There are also electric 5-ton hoists and a Morris runway extending the whole length of the foundry and fettling shop. Large pits and four spindles are provided at one end of the foundry for loam moulding, and a concrete floor at the other end for box work. Immediately adjoining the main foundry is the sand-mixing shop which contains a sand mixer and two modern grinding mills driven by electric motors. A Morris runway extends throughout the full length of the shop and is found to be a great convenience. The fettling shop adjoining the foundry measures 68ft. by 56ft. and is provided with a crane which communicates with the yard.

Electric power is used for the foundry, the alternating current pressure being transformed down from 6000 volts to 440 volts. There is also a direct-current supply of 460 and 230 volts. The switch room is situated next to the fettling shop, oil-immersed switches on the alternating current side and ordinary panel switches on the direct-current side being employed. At the loam end of the foundry are three large core stoves fitted with August muffle furnaces 12ft., 10ft. 6in. and 9ft. by 24ft. long. There are also four small core stoves, three of which are fitted up with portable racks which can be moved in and out mechanically, the fourth being of the drawer type for small oil cores. The core shop is set apart for making oil and ordinary cores.

MACHINE MOULDING DEPARTMENT.

The machine moulding department consists of two shops, the first of which measures 36ft. by 44ft., and is furnished with a set of machines by the Universal System of Machine Moulding Company, for repetition work up to 24in. square. The other shop, size 36ft. by 80ft., contains a Tabor jar ramming and pattern draw machine taking a box 36in. by 24in. In addition to this there is a number of hand ramming, roll-over and pattern draw machines. This shop is also served with a Morris runway, and is traversed by 3-ton electric crane. Sheet steel moulding boxes are extensively used for both hand and machine moulding. Castings from a few pounds up to 3 tons are made in these shops. An independent cupola with a 3-ton capacity has been specially installed for this foundry, and in conjunction with this there is a 10-cwt. electric jib with staging and Keith-Blackman fan driven by a 15 horse-power motor.

Adjoining the core shop is a heating apparatus comprising three units consisting of three Keith-Blackman fans driven by motors which supply cool air during the summer and warm air during the winter to all the shops. No modern foundry is now considered complete without its chemical laboratory. Messrs. Cole, Marchent and Morley's laboratory is equipped with apparatus for analysing iron and coke and making tests of the finished products. There are also carpenters' and smiths' shops for repair work, and a special store for foundry supplies with bins for plumbago, coal dust, blacking, core gum, whitening, &c.; each bin having a hopper to regulate the discharge of the materials.

AN official intimation has been sent to parties interested that the North-Western and Midland Group has withdrawn from its Bill the proposals as to road passenger traffic. The powers sought will be for road traffic only.

A French Forced Draught Furnace.

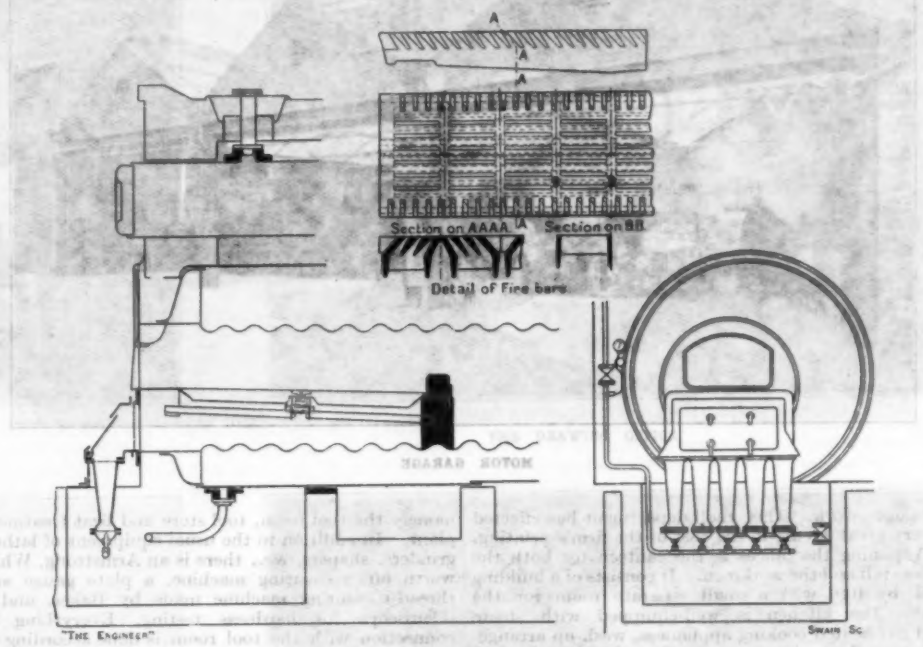
WE have recently received some particulars concerning a new type of forced draught furnace, for burning small coal, which is being manufactured in France by the Société pour la Construction de Fours et Foyers Industrielles of Paris which is represented in England by M. P. L. Dubuis, of 42, London-road, Wembley, Middlesex.

The furnace, of which we give drawings, is fitted to an internally fired boiler, and is chiefly noteworthy on account of the form of the fire-bars employed. These bars, as will be seen from the detail, are each of considerable width, but are pierced by a number of sloping passages for the air, while along one side of each bar there is a series of sloping wings. The openings for the air are said to amount to 40 per cent. of the grate area, but there is very little tendency for fine fuel to drop down through the bars on account of the slope of the passages. The sloping arrangement has another advantage in that the jets of air coming through the bars are made to cross one another, and are thus prevented from producing a sort of blow-pipe action on the fire and burning it through locally.

The forced draught is provided by a series of steam jets, which act as injectors and discharge the air into a casing built on to the front of the ashpit, as shown in the illustration. The pressure under the bars is normally equivalent to from 3 mm. to 4 mm. of water, and this draught is sufficient to burn from 26 lb. to 33 lb. of mixed coal per hour per square foot of grate area, but it is claimed that as much as 88 lb. of Cardiff steam coal can be burned if the furnace is pressed. The makers state that the steam jets use only 2 per cent. of the steam produced by the boiler.

On the front of the draught casing, it will be noticed, there is a door which gives access to the ashpit for clearing out the ashes. This door opens inwards and forms a screen across the tops of the air blowers, so that the ashes do not fall down into them while being raked out.

The furnace is, of course, applicable to boilers of the water-tube type and in such cases the blowers can generally be arranged in the sides of the setting, so that they do not obstruct the ashpit. The ashpit doors have, of course, to be made airtight to prevent the loss of draught.



FRENCH FORCED DRAUGHT FURNACE

Books of Reference.

The Society of British Gas Industries' Directory, 1921. London: Published by the Society.—This is the first issue of the directory, which has been compiled at the suggestion of the Council of the Society of British Gas Industries with the object of arranging in a convenient form the information contained in the catalogues of the firms belonging to the Society. The volume includes some 400 pages and is profusely illustrated. The kind of subject matter will be readily appreciated, and ranges from incandescent mantles and gas cocks to complete gas-making plant.

Ice and Cold Storage Trades' Directory and Handbook for 1922. London: Iliffe and Sons. 10s. 6d.—This directory claims to be the only one of its kind published and is now in its seventeenth year. It has again been revised, with the result that there are several hundreds of additional names in the alphabetical and classified trade sections, while the list of vessels fitted with refrigerating machinery has been brought up to date. This last-mentioned revision is most important on account of the large number of new vessels which have been added to the various fleets and the steamers returned to their owners by the Government. The tables of temperatures, properties and capacities specially applicable to refrigerating work, in the early part of the volume, naturally remain much the same as in earlier issues of the directory.

The Directory of Shipowners, Shipbuilders, and Marine Engineers, 1921. London: The Directory Publishing Company, Limited, Queen Anne's Chambers, S.W. 1. Price 20s. net.—In this volume particulars are given of the leading steamship companies, shipbuilders, ship repairers, and marine engineering works throughout the world. The shipping section contains the names and addresses of the companies and principal officials, with a list of the fleets, and information regarding passenger accommodation, speeds, carrying capacities, and whether oil fuel burning has been installed. In the shipbuilding section the capacities of the shipyards and engine works and the dimensions of dry docks where ship repairing is carried on are given. Much information is included about societies, institutions, and trade and labour federations. A list of consulting naval architects and marine engineers is included.

The Electrical Engineers' Diary, 1922. London: S. Davis and Co. 10s. 6d.—This is the fourteenth year of publication of the diary and several new features have been introduced. Those familiar with the diary will remember that it always contains a large amount of matter in the form of a review of current practice in electrical engineering, and it is, of course, in these parts that the greatest novelties are to be found. In the section dealing with the generation of electricity due attention is given to the latest developments in the use of powdered and oil fuels, while there is an article on the operation of electrical machinery in atmospheres containing gas or oil vapour. In another part some interesting particulars are given of the electrostatic method of separating materials. The official rules and regulations appear as usual, and there are lists of electricity supply plants, streets with cables laid in them, &c., to add to the value of the book.

The Textile Recorder Year-book, 1922. Manchester: John Heywood, Limited. 7s. 6d. net.—This is the first appearance of this little volume, and we imagine that it will be sufficiently popular to continue through a long life. In the preface it is claimed that the work is the most complete encyclopædia of textile knowledge extant in one volume, and it certainly does cover a very wide field, from the production of the raw material, whether silk, cotton, fibre, wool or artificial silk, to the finishing of the final product. There are also a section on fuel economy, which includes general millwrighting, and another on miscellaneous subjects, such as hours of labour, wages, &c. The volume covers over 600 pages and is very well printed, although the type used is, perhaps, somewhat on the small side.

The Commerce and Industries of Switzerland in 1920.—The report for the year 1920 on the commerce and industries of Switzerland, which is published by the Vorort de l'Union Suisse du Commerce et de l'Industrie, is a most comprehensive document which runs to nearly 500 pages. The first twenty-nine pages are devoted to statistical tables giving particulars as to population, professions, water power, numbers of works of different kinds, workmen's wages, traffic returns, foreign commerce, customs receipts, &c. In many cases figures of preceding years are given for the sake of comparison. Following the tables there is a series of chapters each devoted to a single industry, amongst which may be mentioned those referring to silk, cotton, wool, linen, straw, paper, printing, leather and rubber, chemicals, metals, machines of various kinds, clocks, wood, cement, earthenware, brewing, coal, &c. In all cases a most interesting account of the present condition of these industries is given, and in many instances comparisons with past years are also made. An exceedingly interesting section is that devoted to the production and distribution of electrical energy. In it, in addition to much other information, lists are given of all the hydro-electric stations in operation both at the end of 1914 and at the end of 1920, with the horse-power installed in each station. Particulars are also given of the stations under construction at the end of the latter year. The volume as a whole forms a most valuable work of reference on any question concerning the economic position and the commercial activity of Switzerland.

Railway Matters.

A BRONZE memorial to the memory of the 1465 men of the Lancashire and Yorkshire Railway who gave their lives in the war, was unveiled by Lord Haig at Victoria Station, Manchester, on the 14th inst.

THE Glasgow Subway Railway has at last been compelled to cease operations, and it closed down on the 12th inst. The competition of the Corporation tramways has hit it very badly, and last year there was a deficit in the net receipts of £15,000.

AN underground railway for the city of Bombay, nearly 7½ miles in length, has been suggested by the municipal special engineer. The total cost with equipment is estimated at 246 lakhs of rupees. The twin-tube system is recommended as cheaper than one tunnel for a double line.

THE dispute between the Irish railway companies and their men over the Carrigan awards has been settled through the intervention of the Provisional Government. This result is due in a large measure to the joint efforts of the Labour Ministers in the Northern and Southern Governments. The award is to be reviewed at the end of six months.

AT the annual meeting of the Institution of Railway Signal Engineers on the 15th instant, Mr. W. C. Acfield, the signal superintendent of the Midland Railway Company, was elected the President for 1922 and Mr. R. J. Insell, the assistant signal engineer, Great Western Railway, the vice-president. The membership of the Institution is now 370.

THE explanation given at the Brighton Company's meeting on the 15th instant for the withdrawal of the Bill for additional powers is that all the companies in the proposed Southern group are interested in electrification, but each has a different system. The Ministry of Transport has appointed a committee, under Sir Phillip Nash, to report on this condition, and meanwhile nothing can be done.

THE Commercial Secretary to His Majesty's Legation at Christiania reports that, according to the local press, it is proposed to commence immediately preliminary work on the two electric railways for which concessions have been granted to A/S "Akersbanerne." The Ostensjo line, which is to cover a distance of 3.2 kilom., is calculated to cost Kr.720,000 per kilom., while the estimated cost of the Sognsvand line is Kr.700,000 per kilom.

ALTHOUGH the steamers on Loch Tay are shown in the public time tables as part of the Caledonian services, they have belonged to a private company which has run them from Kenmore—for which Aberfeldy on the Highland is the nearest station—to Killin on the Caledonian Railway, Killin being the end of the four-mile branch which joins the Callender and Oban section at Killin Junction. These steamers have now been acquired by the Caledonian Railway Company.

IT will be remembered that a lack of uniformity as to the date for the termination of summer-time last year in England and France caused some inconvenience for a week or so to passengers from France, as they were kept at Dover for an hour extra. This inconvenience has now been met by the British, French and Belgian Governments agreeing to fixed dates. They are the last Saturday in March—the last but one when the last is the eve of Easter Sunday—and the first Sunday in October.

AN innocent-looking announcement was made recently by the Ministry of Transport to the effect that the register of privately-owned wagons, instituted in accordance with the terms of the announcement of February 12th, 1920, had been closed and no orders for wagons would be registered. This statement, we understand, certainly does not mean that no further privately owned wagons are to be built. If anything, it suggests that the idea of their purchase by the State, and by the companies through the State, has been abandoned.

THE Ministry of Transport railway statistics for November, just published, show that, as compared with November, 1920, there was a decrease of 13.2 per cent. in the number of passenger journeys. The reduction in journeys at full fares was 12.3 per cent., and in workmen's journeys 22.3 per cent.; journeys at reduced fares increased 47.9 per cent. The passenger receipts fell by 11.6 per cent. The passenger mileage, notwithstanding, increased 6 per cent., which, it is safe to assume, is the result of competition between the groups.

A STATEMENT by the London General Omnibus Company as to its accidents during 1921 shows that there was a decrease of 10 per cent. in the number of accidents and of 67 per cent. in the number of fatal accidents. A period of sixty-seven days between September and December elapsed without any fatal accident being recorded. This improved record was made despite 1,200,000 car miles more having been run. The mileage lost through breakdowns only represented one-third of a mile per 1000 miles run, which surpasses by a long way all previous records.

ADDRESSING the shareholders of the Midland Railway on the 16th instant, Mr. Charles Booth, the chairman, intimated that he was resigning that office, and that Sir Guy Granet would succeed him. Mr. Booth feels that the responsibilities placed upon him as a result of the Railways Act, combined with his own business in Liverpool, make this step necessary. Sir Guy Granet, being a London man, would be able to devote more time and attention than Mr. Booth possibly could to the difficult and intricate negotiations in which the Midland Company is involved.

THE report of the Committee on National Expenditure, presided over by Sir Eric Geddes, shows that that gentleman wrote to the Chancellor of the Exchequer saying that before he relinquished the position of Minister of Transport he expressed the opinion to the Prime Minister that in view of the passage of the Railways Act, restoring the railways to private ownership, there was no justification for retaining a separate Ministry of Transport, especially having regard to the existing financial stringency. The Committee concurs in this view, and thinks that economy and efficiency would be attained if all questions of transport by sea, rail, road and canal, and questions of power and coal were grouped in the Board of Trade.

Notes and Memoranda.

AN investigation relating to the protecting power and durability of paint on wood is about to be made in America. In view of the great annual expenditure on paint—about 300,000,000 dols.—it is considered desirable to obtain information on the durability both of paint and of the wood which it protects.

IT is reported from Brussels that a radio active ore has been discovered in the subsoil of the Katanga plateaux in the Belgian Congo, and that it is comparatively rich in radium, especially as contrasted with the American ore. The Katanga ore is found almost on a level with the soil. The report adds that works are being erected on the spot for the production of radium, and that it is thought that as much as 30 grammes per annum may be obtained.

THE official report on the explosion of a water-tube boiler on the ss. Berengaria demonstrates the value of non-return stop valves on such occasions. The boiler that failed was one of forty-six which were working at a pressure of 227 lb. per square inch. One of the tubes failed and the escaping steam blew the fire into the stokehold, with fatal results to several firemen, but the pressure in the boiler was reduced to 25 lb. during the time that one of the engineers took to traverse the stokehold, so that it was possible quickly to approach the boiler.

IN connection with the coal strike, the *South African Mining and Engineering Journal* publishes the following particulars relating to the coal mines of the Transvaal taken from the Government Mining Engineer's reports, to show how substantially costs have risen between 1914 and 1920; the figures for 1914 are given in brackets:—Output, 7,180,124 tons (5,157,268 tons); value of coal at pit's mouth, per ton, 8s. 1.12d. (4s. 5.55d.); expenditure—salaries and white wages, per ton, 1s. 3.85d. (10.24d.); native wages, per ton, 1s. 3.69d. (1s. 0.22d.); stores, per ton, 2s. 4.14d. (1s. 3.96d.); total cost, per ton, 4s. 11.68d. (1s. 2.42d.).

A NOVEL use for an electric truck has been discovered by the Consolidated Gas Company of New York. The truck, which is specially equipped with a tank of 250 gallons capacity, is used to collect the liquid left in the gas mains by the condensation which is continually occurring there. The liquid, when collected, is taken to a refining plant, where by-products are obtained from it. The motive power admits of a cruising radius of about 50 miles, besides supplying current to run a 60-volt centrifugal pump. This electric drip wagon, the only one of its kind, is doing the work that formerly required two horse-drawn vehicles. A weighty reason for using an electric truck in this connection is its freedom from risk of fire, which would not be the case if a petrol-driven truck were used.

UNDER the title of "Products of a Blast-furnace," a paper was read by Mr. A. Hutchinson, of the Skinningrove Iron Company, Limited, on January 25th, at the Middlesbrough Technical Institute. Addressed to an audience of working men, it dealt in an elementary manner with the operation of the blast-furnace. Dividing his subject into two parts—(1) products which come out of the bottom or hearth of the furnace, and (2) products from the top of the furnace—the author defined the nature and qualities of pig iron, touched upon the differences in hematite and Cleveland ores, and enlarged upon the influence of phosphorus in the iron. Dealing with other products from the hearth of the furnace, he pointed out the various utilities of slag, and its increasing importance as an ingredient of cement, and in the manufacture of bricks. The latter part of the paper dealt with the developments that have taken place in connection with the utilisation of blast-furnace gas, and the methods adopted for cleaning it.

VENTILATION from a purely economic point of view may be efficient or inefficient, states Mr. R. Roberts in a paper on "The Ventilation of Electrical Machines," read before the Association of Engineering and Shipbuilding Draughtsmen. Efficient ventilation consists in using the minimum quantity of air with the least expenditure of energy to move the air, to produce the desired low temperature on all surfaces of the machine. For ordinary slow-speed machines, this efficiency of ventilation is of little importance, although the author mentions a case in which such a large quantity of air was driven through the machine that the overall mechanical efficiency was lowered to such an extent that its rejection by the customer was a possibility. The actual power required to drive one fan on a 500-kilowatt set was approximately 30 kilowatts. Ventilation cannot be efficient, the author points out, unless all the air circulated is brought as intimately as possible into contact with the heated surfaces within the machine, and it should leave the machine with a temperature rise of from 15 deg. to 30 deg. Fah., dependent upon the type and size of the machine.

IN commenting on the explosion of a boiler stop valve on the ss. Kaisar-i-Hind, the Engineer Surveyor-in-Chief to the Board of Trade points out that the failure of this stop valve chest illustrates the necessity for free expansion in steam-pipe ranges, as well as the desirability of using cast steel for important boiler mountings. Cast iron is, he says, of very variable quality, and possesses little or no ductility, and it rarely gives any visible indication of approaching breakdown under stress. The expansion joints fitted in this range of pipes appear to have been sluggish and irregular in their movements, and consequently considerable stresses were thrown on the neck of the forward stop valve chest by the restricted expansion of the pipe line, resulting in the fracture of the valve chest. The various parts of the range had been under careful observation for some time past owing to the trouble previously experienced, but no indication of failure appears to have been observed until a short time before the chest completely failed. Expansion joints of the type fitted in this case require very accurate alignment, and any deviation therefrom due to structural movements of the vessel or to the different temperatures of the bulkheads through which the pipes pass and the boilers to which the pipes are connected, restricts or prevents the free movement of the pipe line in the expansion joints and imposes a heavy stress on the pipe line attachments to the boilers or bulkheads. The substitution of a type of joint which will not be liable to jamb, and the substitution of cast steel for cast iron stop valve chests should obviate trouble in the future.

Miscellanea.

THE export of coal from the colony of Hong Kong has been prohibited.

DURING the three weeks ending on January 21st, 28th, and February 4th, the amount of coal produced in the United Kingdom rose from 4,560,500 tons to 4,803,100 tons per week.

DURING the past year work on the Krishnarajasagara dam, Mysore, progressed to such an extent that 500ft. of the waste weir were raised to a height of 77ft. above bed level and allowed a flood of 9ft. to pass over. The water stored was sufficient for the requirements of power and hot-weather irrigation.

AT a meeting of the Electricity Committee of the Stretford Urban District Council recently, it was decided to reduce the advances over pre-war rates for electricity as follows:—Power, from 125 to 85 per cent., as from March 1st, and lighting from a maximum of 8d. per unit to 6½d. per unit, as from April 1st.

THE Concrete Institute has been informed that the cost of preserving the ancient arch which was recently discovered under London Bridge would be about £7000. The Institute is organising a conference at Denison House, Vauxhall Bridge-road, on Monday, February 27th, at 5.30 p.m., with the object of discussing the subject.

THE Lung Yen Iron Mining Administration has been formed in China under private and Government joint auspices with a capital of 5,000,000 dols. (say, half a million sterling). The mines are situated at Hsuan-hsafu. The two blast-furnaces, each of 250 tons capacity, which will be finished this summer, are situated at San-chia-tien, which is about 10 miles west of Peking.

THE liner Leviathan will leave her present berth at New York in about three weeks' time for Newport News, where she will be re-conditioned at a cost of 8,200,000 dols. for re-entry into the Transatlantic service. A skeleton force of sixty men has been on board the vessel ever since she was laid up after the conclusion of her work of taking home the American troops from France. Steam has been kept in her boilers, and her screws have been turned a few times daily to keep the shaft bearings in order.

IT is reported from Warsaw that a plan for the construction of a canal to facilitate the transport of coal from Upper Silesia to Dantzig is being elaborated in industrial and financial circles. It is proposed that the canal should start at the Przemsza River and should pass through the towns of Kattowitz, Erby, Czertechowa and Lotz, to Dantzig. One thousand-ton boats would be used for the coal traffic. It is estimated that the construction would take eight years, if 10,000 workers were employed, and the cost is placed at about 230 million gold marks.

IN connection with the death of Sir Ernest Shackleton, the island of South Georgia has been frequently mentioned in the public papers, and it is interesting to note that in this extremely remote island—2000 miles from civilisation—a small ironfoundry is to be erected. The Constructional Engineering Company, Limited, informs us that quite recently it dispatched one of its small complete plants with necessary equipment and requisites to the whaling station at Grytviken. This plant is intended for making castings for repairs to the machinery at this station, and also any necessary repairs to the ships which call at this island three or four times a year.

ACCORDING to the *Manchester Guardian*, at an inquiry held at Runcorn recently into an application of the Urban Council for powers to construct a reservoir on Runcorn Hill for additional water storage, it was mentioned that the present reservoir only sufficed for one day's supply. The water to the town was a mixture of the Vyrnwy water, obtained from the Liverpool Corporation, and the supply from local wells. This mixture had been found to be utterly unsuitable for the works, which were given a supply of the pure Vyrnwy water. The estimated cost of the reservoir is £18,000, and it is hoped that its construction will provide some work for the unemployed.

IT is expected that work will soon be commenced upon the construction of the first power-house at the falls of Iguazu. These falls, which are on the border line between Argentina and Brazil, some 800 miles from Buenos Aires, are composed of 275 cascades, one of which has a sheer fall of 213ft. The plant is to provide for the development, at first, of 150,000 horse-power, which, later on, can be increased to 300,000 horse-power. Four transmission lines will be built, so that in the event of a breakdown of one, the others would become at once available. It is estimated that the project will call for the expenditure of between 30 and 40 million dollars (Argentine gold), and that the actual work of construction will take two and a-half years.

THE Japanese Fushun collieries in Manchuria have planned a ten-year programme of improvements and extensions. Their present daily output is 10,000 tons, but according to plans for the period ending 1929, the output is to be raised from three to eight million tons a year. The improvements include the laying down of a plant for the extraction of petroleum from the oil in the shales above the coal seams. Within three years the Sino-British Kailan Mining Administration hopes to increase its daily output from 15,000 tons to 20,000 tons. The improvements consist in the sinking of a new mine of 5000 tons capacity, enlarging the existing coal-washing plant, erection of by-product ovens, and the construction of a new wharf at Tangku.

THE British Non-ferrous Metals Research Association, of 71, Temple-row, Birmingham, has just issued its second annual report. The association has a membership of over 100 firms, all over the country, including both manufacturers and users of non-ferrous metals. The researches in progress are of a very varied character. Apart from investigations of particular importance to the non-ferrous industry itself, such as those on brass casting and on the influence of impurities on the working properties of copper, of which the latter is being conducted at the National Physical Laboratory by Dr. W. Rosenhain, investigations of more general interest to engineering firms are those on metal polishing and grinding and on the jointing of metals. The electric melting of non-ferrous metals is also receiving attention, and the atmospheric corrosion of non-ferrous metals is being studied.

THE PROSPECT FOUNDRY AT BRADFORD OF COLE, MARCHENT AND MORLEY, LIMITED

(For description see page 210)

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SOUTH AMERICAN BRANCH OFFICE OF

The Engineer.

536, Bolsa de Comercio, Buenos Aires.

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The Engineer can be had, by order, from any newsagent in town or country, at the various railway stations; or it can, if preferred, be supplied direct from this office.
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Postal Address, 33, Norfolk-street, Strand, W.C. 2.
Teleg. Address, "Engineer Newspaper, Estrand, London."
Telephone Nos. 2256, 2257 Central.

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By arrangement with Reuter's Engineering Service, The Engineer contains the latest news from all parts of the world which is likely to be of interest to engineers.

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DEATH.

At his residence, The Willows, Carnoyle, Mr. James Bissett, chairman of R. B. Tennent, Limited, Coatbridge.

THE ENGINEER.

FEBRUARY 24, 1922.

The Washington Naval Treaty.

Although the Five-Power Treaty for the limitation of naval armament is less comprehensive than the original proposals of the American Government, it represents, nevertheless, a truly remarkable achievement of statesmanship, and one to which history affords no parallel. Of all the efforts previously made to arrest competition in naval shipbuilding, none had been crowned with any material degree of success. The first Hague Conference not only failed to effect anything in this direction, but seemed rather to give a fresh impetus to building-slip rivalry among the Great Powers. A similar result followed the informal negotiations which took place between this country and Germany before the war. With these discouraging precedents in memory, Mr. Harding and his Cabinet showed great resolution in convoking the Washington Conference, knowing as they did that failure would inevitably leave the international situation in a worse state than it was before. This time, however, there were circumstances which seemed to justify confidence in a successful issue. The nations had had their fill of fighting, and desired nothing so much as a prolonged period of peace in which to repair the havoc of war. Nor were their finances equal to the strain of a new competition in armaments. The entire civilised world was involved in the tidal wave of economic depression which followed the great upheaval of 1914–1918. In many countries, including our own, taxation had reached an almost intolerable figure, and the prospect of adding further to the burden by heavy expenditure on weapons of war was one that appalled every thoughtful mind. Yet, until recently, there seemed no escape from this dire predicament. Owing to the great shipbuilding programmes on which the United States and Japan were engaged, the balance of naval power, as it existed immediately after the war, threatened to swing heavily against the British Empire, relegating our Navy to a position of marked inferiority. This was a contingency which could not be viewed with indifference, however friendly our relations with the two Powers in question. To accept equality in strength with the United States was one thing; to sink to third place in the naval hierarchy was quite another. Straitened though its finances might be, the country would certainly not have assented to this renunciation of its sea power. But, on the other hand, it was no light undertaking to resume competitive building at a time when each new battleship entailed a capital outlay of more than seven millions. As is well known, the Admiralty experienced considerable difficulty in obtaining the Government's sanction to last year's relatively modest programme of four capital ships; yet it was clear to all that, if the one-power standard was to be maintained, much heavier expenditure would be necessary in the near future. Equality *vis-à-vis* the United States would have meant laying down at least four keels each year for the next few years, with corresponding provision of ancillary craft of all types, and the construction of docks and harbour works suitable to the enormous dimensions of the new leviathans. Such was the staggering prospect that confronted us last year. Now, thanks to the courageous initiative of President Harding and the whole-hearted co-operation of the several Governments represented at the Conference, rivalry in the output of battleships is at an end; both America and Japan having agreed to annul the greater part of their respective building schemes, we are no longer under the necessity of embarking on a large and ruinously expensive programme of warship construction.

The principal effects of the Naval Treaty—which we summarise on another page—will be to suspend the building of capital ships for a period of ten years, with the exception of two vessels which this country is authorised to lay down in order to compensate for the retention of post-Jutland ships by the United States and Japan; the limitation of aircraft-carrier tonnage to a fixed aggregate for each of the signatory Powers; and the restriction of displacement in the case of capital ships, aircraft-carriers and cruisers which may be built in future. Competition is avoided by fixing a constant ratio of tonnage for each of the five leading navies as regards capital ships and aircraft-carriers. Cruising ships and smaller types are beyond the scope of the agreement, their exclusion being due to the failure of the Conference to limit submarine armaments. The entire Treaty bears evidence of having been framed with meticulous care, and is singularly free from ambiguities. It would be too much to expect an immediate and substantial reduction in naval expenditure as the result of this compact. Unlike the United States or Japan, our actual building commitments were small, for we had not laid down any one of the four ships authorised last year, though a certain amount of preliminary work had been done by the contractors. Where we do stand to benefit very considerably is in respect of the Navy Estimates for future years, which would have remained at a very high level had we been compelled to build up to the one-Power standard. An annual programme of even two ships—which would have been demonstrably inadequate—would have involved a serious drain on the national exchequer, for, as we have mentioned above, there has been a startling increase in the cost of capital ships since 1914, accounted for in part by larger dimensions and in part by the higher price of labour and material. It will be opportune to present a few figures illustrating the combined effect of this dual increase. The four ships of the "Iron Duke" class, completed in 1914, each displaced 25,000 tons, and their average cost was £1,890,000. The Queen Elizabeth, of 27,500 tons, completed early in 1915, cost just over £3,000,000, according to a statement in the House of Commons last May. The bill for the Hood, displacing 41,200 tons and completed in 1920, reached £6,025,000. As for the new battle-cruisers, which would now have been on the stocks but for the Conference, the Admiralty had tentatively estimated their cost at £7,500,000 each. Their displacement was not officially divulged; but we notice that the American Secretary of State, Mr. Hughes, in submitting the Naval Treaty to the plenary session of the Conference on February 1st, said that the two battleships which Great Britain was entitled to build pursuant to the Treaty "are not ships of the size contemplated by the four Hoods, which was in the neighbourhood of 48,000 or 49,000 tons." It appears, therefore, that a further striking advance in capital ship dimensions was contemplated, and as other nations would no doubt have followed suit, the 50,000-ton mark would soon have been reached and passed. A few years hence, £10,000,000 would quite possibly have become the average price for a new battleship. Nor, in reckoning up what the Conference has saved the tax-paying community, must we omit the cost of the new docks which would necessarily have been built at the home and oversea naval bases to accommodate these mastodons, or the expense of keeping the ships in commission. Already it costs between £450,000 and £500,000 per annum to maintain a modern capital ship in service with the Fleet. No one who studies these figures will deny the extent of the boon which the Washington

Naval Treaty confers upon the party nations, and not least upon our own.

But having acknowledged the blessings which are likely to flow from the achievements of the Conference, we are bound to confess that they would have been hailed with even more enthusiasm had they not chanced to coincide with a period of unexampled depression in the industries primarily affected by the naval limitation scheme. Business in the shipbuilding world is at its lowest ebb, as also are the many and diverse trades affiliated with shipbuilding. In these circumstances Admiralty contracts have an importance which does not attach to them in normal times, and it was hoped that the work accruing from the four battle-cruisers ordered last October would help to keep the various industries going until the return of healthier economic conditions. For this reason the modification of the building programme is a serious blow to British shipbuilding, and is certain to react unfavourably on unemployment and general trade conditions. It is true that we are entitled to lay down two 35,000-ton battleships as soon as we please, and the prompt award of contracts for them would do something to mitigate the present serious state of affairs; but even if the designs were completed it is doubtful whether immediate action would be taken. Now that the Naval Treaty has been followed by the Geddes report, the Government, it is rumoured, is inclined to reconsider the whole question of naval policy with a view to further retrenchment, in which case it may be decided to postpone the laying down of the new ships. An announcement on the subject is likely to be made when the Navy Estimates are introduced next month, and will be eagerly awaited.

The Grouping of the Railways.

ALL the information the Midland chairman gave the shareholders yesterday week on the subject of that company's amalgamation in the North-Western, Midland and West Scottish group was that the directors were giving their most serious consideration to the many important points which arose on the application of the statute. On this subject a great deal appeared in the daily newspapers a fortnight ago, based on a statement made on the 6th instant by the *Manchester Guardian* that the amalgamation of the London and North-Western and Lancashire and Yorkshire companies having been completed and set in motion, the directors of the former company had been occupied in bringing the Midland company into that group. Our contemporary spoke of the negotiations having been materially assisted towards a successful termination, and went as far as to say that the terms would shortly be submitted to the shareholders for ratification. The two companies have, under the Railways Act of last year, to be amalgamated, but, as we remarked in our Railway Matters column of the 10th instant, matters can hardly have progressed as fast as is suggested. The strong financial position of the Midland company, together with its traffic-earning capacity and transportation facilities—which latter are, in many ways, as good as those of the North-Western—is such that the terms would have had to have been very attractive to have won so readily the Midland board's approval. In railway circles it is thought, as we also observed, that the standing of the Midland company is such that the conditions under which it would agree to amalgamation, are likely to lead to the scheme for amalgamation having to be "prepared and settled" by the Railway Amalgamation Tribunal under Section (3) of the Railways Act, and the appointment of Sir Guy Granet as the chairman of the company means that it intends to make a good stand to enter the group on its own terms. With the Lancashire and Yorkshire Railway it was altogether different. For nearly sixty years, as we pointed out in our issue of April 1st last, these two companies had a working agreement; fifty years ago they proposed to amalgamate, and in 1904 the original working agreement was once more modified so as to eliminate all competition. It is true also that the Great Western has come to terms with the six companies which are to be amalgamated with it, but one stood out—the Barry—which, again, is one of the more prosperous companies, and it had to be given a perpetual 11 per cent. before it consented. Herein lies the main difficulty to be overcome before a strong company will agree to amalgamation. What may be called the initial companies in grouping—the London and North-Western, Great Western, North-Eastern and London and South-Western—have necessarily to make the first move and to suggest terms. The Lancashire and Yorkshire was a fine property, which had been well maintained during the war, and this fact was reflected in the offer made by the London and North-Western. The chairman of the latter told the shareholders on November 17th, "as we were the wooing party we have thought it well to deal perhaps somewhat generously on an income basis with the other party concerned." Few other companies, not being the initial companies, are in the same strong financial and physical position as the Midland, the Barry and the Lancashire and Yorkshire. The only two we can think of are the North Staffordshire and the Glasgow and South-Western, whilst a company that, owing to its improved traffic-earning facilities, calls for better treatment than an "as in 1913" basis, is the Great Central.

The fact is that compulsory amalgamation of the whole of the British railways into four companies is the dream of a visionary. Sir Eric Geddes, as we have more than once remarked, evidently got the idea from the United States, where, in the respective Bills of Senators Esch and Cummings in 1918, the grouping of the American railways was proposed. This proposal was accepted, but it is important to note that (1) no time limit was placed on the preparation of a grouping plan, and (2) the amalgamations are not compulsory. In this country, under the Railways Act, the schemes for the absorption of the subsidiary companies and for the amalgamation of the constituent companies are to be in the hands of the Minister of Transport by the end of this year, and every amalgamation scheme and every absorption scheme is to be so framed as to come into operation by July 1st, 1923. Amalgamation being compulsory, negotiations with some parties becomes difficult, as they are not willing to be extinguished. They may consider their property to be of such value as to feel that their independent status would be more profitable to their proprietors than absorption in a group. One cannot but appreciate such an argument, as it is obvious that the richer companies will have to carry the burdens of the poorer, and that it will take more economies than are at present in sight to maintain the profits of the more prosperous concerns. Another difficulty is the absence of any sound basis on which to make a valuation for amalgamation. The fairest and easiest way all round would be to accept the figures of 1913, but much has happened in the eight years since then. Many companies have had their property added to, improved and made of greater earning capacity, all items which must come into account when agreeing as to the terms. Other companies have been able to maintain their road and rolling stock in better condition than their neighbours; perhaps because the latter had a greater war traffic, or, perchance, because the pre-war upkeep of the former companies was superior and they were in a better position to contend with the strain of the war period. Whilst it is out of the question to make a physical valuation for the purpose of determining the condition of the property, these are points that might have to be taken into account. Yet another difficulty is the fact that if improved terms are given to one member of a group the other members will have to make up that amount. For instance, let A, B, C, D and E be five companies to be amalgamated, whose respective value, based, say, on the net receipts of 1913, are 30, 25, 20, 15 and 10 per cent. of the whole. Company C is obdurate and refuses to join. In order to overcome its objection, company A, which, being the biggest, takes the initiative, offers to give C 22 per cent. instead of 20. That means either that the four companies suffer, or that, like the North-Western with the Lancashire and Yorkshire, the "wooing party" takes 28 per cent. instead of 30. In the latter event, A lowers its own value, which is not only an important matter for its shareholders, but, more important still, the value of A to B, D and E is affected.

It is a matter of no little satisfaction to us to find that the opinions we expressed in a leading article in our issue of May 20th last, after the Railways Bill had been introduced, are now heard in many quarters. For instance, the chairman of the Brighton Railway spoke on the 15th instant of the paralysing effect of the Railways Act; how a pool of receipts and expenses could have been arranged without great difficulty, but when it came to a fusion of the four southern companies the problem became much more difficult; and how the provisions as to grouping in the Act should have been permissive instead of compulsory. Then, in its issue of the 10th instant, our contemporary, the *Railway Gazette*, in an article entitled "Should the Railways Act be Amended?" asked "whether it would not be better for the country and the railways to leave the process of amalgamation to take its natural course." In our article just referred to we observed: "We are not opposed to the absorption of the one hundred and five subsidiary companies; on the contrary, we think they should be absorbed. But for the present that is as far as we would go. We would leave the twenty principal companies alone; let the proposed Amalgamation Tribunal be appointed and allow amalgamations between the principal companies to be brought about voluntarily and gradually, provided that, after public inquiry, the Tribunal approves. But to compel these twenty companies to group themselves into six (now four) groups within a twelvemonth is, we consider, a leap in the dark. We see many objections to the scheme now submitted. One objection is that the groups are unwieldy and cannot be properly administered. Another is that such gigantic corporations cannot have the same local interest, and its officers the same local touch, that exists to-day." To these observations we would add that, as already noted, the Transportation Act, 1920, does not make the grouping of the United States railways compulsory; the only mandatory requirements are that all future consolidations shall follow a pre-determined plan, and this plan shall provide for the grouping to be in accordance with the existing flow of traffic and for the retention of competition between the groups.

Rotary Converters for Railway Work.

WHEN it was found that by providing the armature of a direct-current dynamo with slip rings and by connecting them to appropriate points on the winding the machine could be employed for converting alternating current into direct current, or *vice versâ*, an important advance in electrical engineering was made, for apart from the simplicity of a converter of this sort, its efficiency is distinctly better than that of the motor generator, which, prior to the introduction of the rotary, was utilised almost exclusively for converting one kind of current into another. Those who were associated with the rotary when it was first introduced know that its operation was not always perfect, and it was not considered to be a suitable machine for use on 50-cycle circuits. Hunting and sparking troubles were very pronounced when attempts were made to run the new machine with current having a periodicity of more than 25 or at most 33 cycles, and for a while its employment was somewhat restricted; but in consequence of the provision of damping arrangements, commutating poles and other improvements in design, and to some extent, we think, the even turning moment of the steam turbine, the early troubles were overcome. Other improvements that have been made, apart from those necessary to secure immunity from hunting and sparking, are connected with voltage regulation, starting, and the prevention of flashing over at the brushes when short circuits occur on the line.

New problems have, however, presented themselves in consequence of the demand for higher pressure direct currents for working electric railways. That a track pressure above that which has hitherto been utilised on most of the railways in this country is needed for main line electrification is now freely admitted by all electrical engineers, although there is nothing like complete agreement as to what this pressure should be. On the assumption, however, that the standardised pressure of 1500 volts is going to be adopted, the electrical manufacturers have wisely directed their attention to the problems associated with 1500-volt converters. They see that if this policy is pursued the demand for rotaries will be great, and they are making preparations to meet it. Obviously it is not for them to insist that in some instances this pressure is much too low, and that if the 15,000-volt single-phase system were recommended there would be no need to use converters at all. We have no fault to find, therefore, with Mr. F. P. Whitaker for having read a paper before the Institution of Electrical Engineers on "Rotary Converters with Special Reference to Railway Electrification," for apart altogether from the business aspect of the matter it is not an electrical designer's business to dictate policy, but to apply his knowledge and skill to the development of the particular kind of machinery that happens to be called for. Nevertheless, the paper does not contain anything which causes us to view the adoption of a standard pressure of 1500 volts in a more favourable light than before. In fact, if anything, it strengthens our conviction that the production of high pressure

direct current is anything but a simple and straightforward job. Hitherto we have imagined, when considering the equipment of 1500-volt substations, that the current would always be supplied from single commutator machines, but it appears from Mr. Whitaker's paper that with a 50-cycle three-phase supply—which, incidentally, is what the Electricity Commissioners seem to be mainly aiming at—two rotary converters will have to be connected in series. In fairness to Mr. Whittaker, and to one or two speakers who took part in the discussion, we must note that the construction of a 1500-volt machine is not considered to be impossible, but it certainly appears that as yet, at any rate, it is desirable in the interests of reliability to use two machines for 50-cycle current. What the cost per kilowatt of these series-connected converters, together with transformers and switchgear, amounts to we do not know, nor are we in possession of much information concerning the possibilities of the motor converter. Mr. Roger Smith, who is one of the users of these machines, and who took part in the discussion on the paper, was not at all pleased with the idea of using two 750-volt rotaries in series. His opinion seems to be that as the periodicity of the current supplied through the tappings to the direct-current armature of a motor converter is only half that of the supply, this type of machine is better suited for high-pressure direct current than is the rotary converter. Mr. Whitaker also shows in his paper that as an alternative to two rotaries a motor converter might be used, but he gives no figures concerning the relative cost or the space required. Up to pressures of 12,000 volts the motor converter can, we believe, be used without transformers, which is, of course, an important consideration; but with the transmission pressures now coming into use, transformers would certainly be needed. In any case we agree with Mr. Roger Smith in his contention that the employment of two series-connected rotaries should if possible be avoided. Nor do we think that the proposed sub-station equipment for the 3000-volt direct-current railway is particularly attractive, for in this case it is shown to be necessary to resort to the use of motor generators, which are known to be the most inefficient of all converting machines. On the other hand, the higher pressure would naturally enable the sub-stations to be spaced farther apart. The mercury vapour rectifier may in time to come offer a better solution to the conversion problem. It, however, is a relatively new piece of apparatus which is only just beginning to be installed in this country, and has not yet become a very formidable competitor of other forms of converters.

The more we examine the equipment required for high-tension direct-current lines the more desirable does it appear that the possibilities of the 15,000-volt single-phase system should be properly looked into. For the ingenuity that has been brought to bear upon the design of high-tension converting plant we have the greatest admiration, and we do not believe that the high-pressure direct-current system ought never to be adopted. What we do believe and have believed and emphasised for a good many years is that direct current will not meet all requirements to the best advantage. We have expressed this opinion so often that our readers must, we fear, be rather tired of meeting with it. Still, in view of the fact that the idea is undoubtedly spreading, and that at several recent meetings prominent engineers have spoken in favour of single-phase electrification, our persistence will perhaps be excused. This simple and straightforward system, which requires no link between the generating station and railway beyond widely spaced transformers, which, compared with converting plant, are relatively cheap, and which may, if suitably designed, be erected in the open, can scarcely fail, we think, to show marked advantage on long stretches of track on which the traffic is not very dense.

Owners and Shop Management.

IT is hardly desirable at the present moment to do more than put on record the fact that owing to the failure of prolonged negotiations with the Amalgamated Engineering Union, the Engineering Employers' and National Employers' Federations have announced that notices will at once be posted to the effect that as from March 11th the shops will be closed to members of the A.E.U. This decision has been reached as the result of a recent ballot on a memorandum in which the essential clause ran as follows:—"The trade union shall not interfere with the right of the employers to exercise managerial functions in their establishments, and the Federations shall not interfere with the proper functions of the trade union." The real issue at the back of the whole matter is whether or not employers shall have the right to say when overtime is to be worked or night work carried on. The proportion of the men who voted as compared with the total membership of the A.E.U. was not large, and the preponderance of the adverse vote is not considerable, but the employers had no other alternative than to proceed with the lock-out unless they were to content themselves with a continuance of a state of affairs which they are convinced hampers the recovery and development of the engineering industries. They seek, and they seek properly, to restore to their own hands the management of their own factories. The total membership of the A.E.U. is, in round figures, 407,000; the adverse voters numbered 50,240, and those favourable to the memorandum 35,525. At the present time approximately 93,000 of the members are unemployed, leaving 314,000 that may be affected by the lock-out notices. It is perhaps desirable to add that the lock-out has no connection with the dispute as to the reduction of wages in the shipbuilding trades. We do not desire to say more on the matter on the present occasion, because it is so far unknown what collateral developments are in the air, but it must be obvious to all who think of these industrial questions that the employers are fighting for a principle which events have been shown to be essential to the engineering industries, whilst the union, or at least that part of it which has voted adversely, stands for a new principle in trades unionism which approaches communism. The smallness of the vote—the large number of abstentions—is a favourable sign, and if acrimony can be kept out of the dispute it is still possible that the more moderate section of the A.E.U. may override the others and bring the trouble to an early and satisfactory conclusion.

Literature.

Jane's Fighting Ships, 1921. Edited by OSCAR PARKES, M.B., and MAURICE PRENDERGAST. Sampson Low, Marston and Co., Limited. 52s. 6d. net.

JANE'S "Fighting Ships," now in its twenty-fourth year of publication, holds a unique and commanding position among the works of reference devoted to naval affairs. Specialising as it has done from the beginning in the pictorial representation of the world's combatant fleets, its sphere has now been broadened to include a series of "memoirs" dealing with the organisation of the principal navies. This is a very welcome addition, for the information contained in these special articles is not to be found in other textbooks, and will be of real value not merely to professional sailors, but to all who have an interest in studying the methods by which the complicated machinery of a great modern navy is controlled and administered. In the case of the British Navy, time, unfortunately, did not permit of the inclusion of a memoir, which is reserved for a future issue; but long and very detailed articles preface the United States, Japanese, French, and Italian sections, and as the arrangement of all the memoirs is based upon a common plan, it is an easy matter to compare, let us say, the American and Japanese systems of entering and training *personnel* or of staff organisation.

As the bulk of the volume was in the press before the decisions of the Washington Conference on naval disarmament had been promulgated, it was impossible to delete the many ships, old and new, which are to be discarded in accordance with the Hughes programme. Their retention, however, is really an advantage, for it enables the reader to measure at a glance the far-reaching effects of the scheme. Had anyone suggested a few months ago that either Japan or the United States would consent to abandon practically all the magnificent fighting ships they were then building, and which, had they been completed, would have surpassed all predecessors in size and fighting power, the idea would have been dismissed as absurd. Nevertheless, this unparalleled sacrifice is about to be made by the Powers concerned. What it signifies in the material aspect is revealed by the plans and details of the condemned ships as set forth in the present volume. One point which appears to have escaped public notice is that, although the United States proposes to scrap thirteen capital ships, only one of these ships is actually in the water, the other twelve being still in an early stage of construction. Japan, on the other hand, is called upon to break up four capital ships, of which two—Kaga and Tosa—are already afloat, and the remaining two—Amagi and Akagi—are very near the launching stage. This point deserves emphasis in fairness to Japan, whose sacrifice in the cause of disarmament is more substantial than might at first sight appear.

Few modifications have been made in the British section, for, with minor exceptions, no new vessels have joined the flag during the past twelve months. Particulars of the four battle-cruisers authorised last year are withheld. The construction of these vessels has been postponed *sine die*, but it is to be hoped that in due course we shall be permitted to learn the essential characteristics of their design, embodying as it did the very latest principles of capital ship construction as interpreted by the light of war experience. New plans and photographs appear in this section, the light cruiser pages having been practically re-illustrated, and very complete details are given of our submarines and aircraft-carriers. No effort has been spared to give a worthy setting to the United States Navy. There are specially large views of all the comp'eted Dreadnoughts, and most of the plans have been revised from official drawings. The huge flotilla of destroyers which came into being through the war is carefully classified, and a great deal of new information is given relative to the submarine flotilla, which now includes 148 boats, not all of which are completed. The largest of these are three "fleet submarines" recently laid down. They are to be about 335ft. in length, with a surface displacement of 2025 tons and a speed of 21–22 knots. The machinery is reported to consist of two sets of 2400 brake horse-power Busch-Sulzer engines, situated aft, for the main drive, and two 850 brake horse-power Diesel auxiliary engines forward, driving generators supplying current to the electric motors; these latter, together with the smaller engines, being available for surface cruising with electric drive. The hull is to be of great strength in order to resist depth-charge attack. The armament will comprise six 21in. torpedo tubes, one 5in. gun on a high-angle mounting, and one 3in. anti-aircraft gun. These submarines are the largest now under construction, so far as is known, though they may be outclassed by the Japanese submersible cruisers which are unofficially reported as building.

The joint editors, having made a gallant and seemingly successful attempt to explore the intricacies of Japanese naval legislation during the past few years, are thus able to present a clear summary of the successive programmes which culminated in the much-talked-of "eight-eight" scheme, the object of which was to provide two squadrons, each numbering eight capital ships, of which no unit was to be more than eight years old. This project, which would not have matured before 1928, has, of course, been cancelled by the Washington agreement, the only ships surviving being the Nagato and Mutsu. It would have necessitated the laying down of two capital ships per year in order to maintain the specified age average, and since the auxiliary ships of this fleet were presumably also to have been of the most modern type, the annual appropriation for new construction alone would have reached a very high figure. By accepting the American limitation proposals, Japan has therefore relieved herself of a severe financial burden, and this without forfeiting any degree of relative strength. A large number of up-to-date photographs, supplemented with well-drawn diagrams, has been added to the Japanese section, which, in view of recent events, will doubtless come in for particular attention. Among the latest vessels illustrated are the battleship Nagato, the light cruisers of the "Kuma" class, with their curious tandem disposition of the forward guns; and new destroyers and submarines.

A perusal of the French section scarcely bears out the somewhat sensational stories lately current with regard to the maritime aspirations of our good neighbour across the Channel. More than eight years have elapsed since the last French Dreadnought was launched, and a much longer period since any cruisers were built. The French Navy, moreover, is ill-supplied with destroyers, nor can all of its fifty submarines be rated as fully effective. It is true that a new programme has lately been adopted, embracing light cruisers, destroyers, and submarines; but this has yet to assume concrete form, and political fluctuations may lead to its amendment before a single vessel has been commenced. According to the data published in "Fighting Ships," the trouble with heavy oil engines which formerly imposed a heavy handicap on French submarine development has now been overcome, and the latest vessels, notably the Fulton and Joessel, are said to be highly successful, having exceeded their designed speed of 16½ knots. These boats were originally intended to be steam-driven, a method of propulsion for submarine craft which has found more favour in France than elsewhere; but eventually it was decided to equip them with a new type of Diesel engine, which has given excellent results.

The minor navies receive their usual generous meed of attention, and, with the exception of the German fleet—from which the war-time veil of secrecy does not yet appear to have been lifted—all bear traces of the painstaking revision which makes this volume so valuable for purposes of reference, whether the point at issue concerns a British battleship or a Chinese gunboat. The "make-up" and printing leave nothing to be desired. Illustrations and letterpress alike are of an admirable clearness, and the indexing is all that it should be. It is a pleasure to congratulate the joint editors on having produced a work that is a model of its kind. Just as good wine needs no bush, so would it be superfluous to expatiate on the merits of a volume which is assured in advance of an honoured place on the bookshelf of every naval student.

Institution of Mechanical Engineers.

Alteration of By-laws.

The sixty-fifth annual general meeting of the Institution of Mechanical Engineers was held in London on Friday evening of last week. The proceedings were begun at 5.30 p.m., with an extraordinary general meeting for the purpose of considering and, if thought fit, of passing certain alterations in the articles of association as discussed and amended at the extraordinary general meeting on January 20th. This formality was speedily disposed of, but before the annual report of the Council could be taken the meeting had to undergo a tedious and in many respects unnecessary discussion of some alterations in the by-laws proposed by the Council.

In the end the alterations were carried in their entirety, except for two minor changes; one being directed towards the correction of a typographical error and the other towards securing liberty to an author to publish or otherwise use any paper if after twelve months' from the date of its submission to the Institution the Council had neither published it nor intimated its acceptance. There was considerable opposition expressed by small minorities and individuals to some of the proposed alterations, particularly to that in which it was specified that in making out their ballot lists for the election of members of Council, members should now be required to vote for as many candidates as there were vacancies to be filled, thus depriving them of the option previously possessed of voting for fewer candidates—even for but one if they so wished. It was pointed out by those in favour of the alteration that the old by-law laid the way open to the formation of cabals to secure the return to the Council of some particular candidate, and that by permitting a member to vote for but one candidate it could be used to give his particular vote five times the power it ought to have. The alteration as framed by the Council was duly carried in spite of the usual protests from the usual quarters that the meeting was not sufficiently representative of the Institution as a whole to warrant its taking upon itself the responsibility for so changing the constitution of the Institution in this and other respects.

Annual Report of the Council.

The annual report was then summarised by the President, Captain Sankey. It recorded a net increase in the membership of 491, the total on the roll at the end of 1921 being 7994. The total revenue for the year amounted to £29,587 and the expenditure to £27,537. As a result of the labours of three special committees appointed a year ago to consider items of revenue and expenditure, considerable economies were effected in the year's working.

In dealing with the work of the various research committees the report stated that the Alloys Research Committee having completed its study of the aluminium alloys was continuing its investigations on the alloys of iron. For the Cutting Tools Research Committee, Professor Coker, with the aid of transparent models and polarised light, conducted a research on the stresses in tools and material cut. The results of this research are to be presented in a paper during the current session. Colonel Crompton for the same committee carried out a series of tests on the simplest form of cutting. For the Hardness Tests Research Committee, Dr. Stanton, at the National Physical Laboratory, carried out a comparison of ball and cone tests and of scratch and indentation tests for very hard steels. The efficiency of Parsons nozzles was investigated at the Dickinson-street Power Station, Manchester, on behalf of the Steam Nozzles Research Committee. This Committee expended £936 during the year and now has a cash balance of £196. At Woolwich Polytechnic, Dr. Scoble conducted a research on repeated bending tests of wire ropes for the Wire Ropes Research Committee.

Among other items of interest in the report we note that the Thomas Hawksley Gold Medal for 1922 was awarded to Professor Coker and Mr. Chakko for their paper on "Contact Pressures and Stresses." In the April and October examinations, 108 candidates passed the graduateship and 68 the associate membership examinations. In conjunction with the Board of Education a scheme was worked out for the award of National Certificates and Diplomas to students attending part-time and full-time courses at approved technical schools and colleges. Over fifty schools have already applied for the joint approval of the Institution, and the Board of Education. The Institution's local branches in the Midlands, the North-Western district and Yorkshire continued to work very successfully during the year. The respective memberships now amount to 557, 915 and 525. Towards the end of the year a fourth local branch, the South Wales, was formally established. The membersfip of this branch is now 161. The question of the co-operation of engineering societies on lines somewhat similar to those found in America was considered during the year as an outcome of the visit during the summer of the Delegation of Engineers from America. The Institution of Civil Engineers was approached in the matter and agreed to call a conference to ascertain whether and if so in what respects such an object was desirable.

In amplification of the report, Captain Sankey stated that in the steam nozzles research, some most important results were being obtained, and the work it was hoped would be completed this year. To complete the Committee's programme about £800 was required, but only a small part of such sum would probably have to be found by the Institution.

The report was finally adopted, although here again the patience of the general body of those present was somewhat strained by some members who chose to exercise their right and opportunity to criticise the Council and its conduct of the Institution's business.

Council Election.

The next item on the programme was the announcement of the results of the ballot for the election of officers. The election results were as follows:—As President, Dr. Hele Shaw; as Vice-presidents, Sir Henry Fowler, Sir John Dewrance, Sir Gerard Muntz, Sir Vincent Raven and Mr. Patchell; as members of Council, Lieut.-Colonel Kitson Clark, Mr. Petter, Mr. Livens, Dr. Lanchester, Mr. Legros and Mr. Roberts. After the Institution prizes had been presented, Captain Sankey vacated the presidential chair in favour of Dr. Hele-Shaw. Fitting and well-merited tributes to Captain Sankey's energy and ability as President were paid by Sir John Dewrance, Sir Gerard Muntz, and Dr. Hele-Shaw.

It was now 7.25 p.m., but even yet the item on the programme that had brought many members and visitors to the meeting had not been reached, namely, the reading and discussion of Mr. A. T. Wall's paper entitled "Electric Welding Applied to Steel Construction, with Special Reference to Ships." As it was not convenient to adjourn the consideration of the paper to a later date, and as the members present clearly intimated their desire to hear Mr. Wall, it was decided to extend the meeting for half an hour or so. We give below the concluding portion of Mr. Wall's paper, from which its general tenour may be gathered.

Electric Welding of Ships.

"There is very ample scope for the application of electric welding to the structure of a ship, or to any other steel structure. The details should be worked out by co-operation between the office and the yard. It would result in more efficient structures because of better joints and this with less material. If judiciously applied the cost need not be greater than with riveting. This is especially true if, as it should be, the increased earning capacity of a vessel, due to increased deadweight, is taken into account, since first cost is by no means the only consideration. It would be expected that there should also be a reduced upkeep cost. Necessary repairs by damage should not be difficult, as welding plants are now to be found all over the world. The saving of weight is of particular value in warships and high-speed merchant vessels, such as Channel steamers, because the horse-power required to propel them can be considerably reduced. In a modern battle-cruiser, for example, every ton saved on any particular item results in a saving of 3 tons or more in the total weight of the vessel. This saving of weight is also important in any structure which has to carry its own weight.

"Experiments show that the strain in a welded joint is practically identical with that in the mild steel, up to the yield-point. A riveted joint up to its elastic slip value behaves in the same manner. This latter is approximately one-half the yield stress of the mild steel, and therefore the riveted joint afterwards slips by a greater amount than the steel strains under the same stress. A welded structure is therefore more homogeneous than a riveted one. Further experience would appear to be necessary before saying definitely that, in a combination of riveted and welded joints, the greater slip of the riveted joints after the stress exceeds its elastic slip value would throw all the stress on to the welded joints; but in any case such a contingency should be avoided, because it would appear to be unwise to stress a riveted joint beyond its elastic slip value.

"With regard to ultimate extensibility and contraction of area of a butt-welded mild-steel piece, these are not as great as in a plain piece of mild steel. This would not appear to be a drawback, because the extensibility of the weld at its breaking point is about sixty times its extensibility at the yield-point, giving a good margin. If, in the future, steel is produced for structural work with higher mechanical qualities than the present mild steel, it follows from what has been said on riveted joints that riveting will not give the extra strength commensurate with the better steel, and welding appears to present the best and probably the only solution. Where electric welding is referred to in this paper, for strength parts, reliable arc welding is meant; spot or resistance welding is dangerous in structural work because an oxide line must of necessity be produced at the junction between the two surfaces, and the unwelded portions act as leading cracks, causing failure through the oxide line.

"All that has been stated has been based on the assumption that the welding has been properly carried out. Good welding is essential and depends on the use of an efficient electrode and a capable and conscientious welder. The first of these conditions can easily be met by specification and test. Lloyd's Register, and it is believed the British Admiralty, have already framed tests which would satisfy them. Makers who specialise in the manufacture of electrodes could be depended on to provide suitable material. There is, perhaps, a tendency to-day to use what might be described as 'home-made' and imitative electrodes, which are often quite unreliable; even bare-wire electrodes are sometimes suggested. An efficient electrode, amongst other things, should clean the surface of the adjacent metal, prevent oxidisation of the deposited metal, and be easy to control.

"The second condition introduces the question of the "human element." Without doubt the welders should have received specialised training, and should prove themselves not only capable of doing satisfactory work, but should be morally incapable of doing scamped work or covering up bad work. But even this matter should be looked at from a broad point of view. Such qualifications are not entirely confined to electric welding, although in this, a comparatively new process, it is only right that careful attention should be given to the matter.

"At the present time it is necessary to depend on the skill and integrity of workmen in almost every trade, as it is practically impossible to supervise every part of a process or check every measurement, but naturally the most trustworthy men are placed on the more important and higher technical work. This would be the case with electric welding, where applied to structural work. Reference need only be made to the work of the forge-master in building up large forgings, and the smelter, the moulder, and founder, or the blacksmith on ordinary welding work, to appreciate how fully the individual worker must be trusted. This applies equally well to the accuracy associated with the arts of the pattern-maker, the joiner, and all the numerous precision workers in wood or metal. It will undoubtedly be the considered judgment of those with experience in electric welding that only the usual amount of supervision would be necessary to maintain in welding, as applied to structural work, the same character for high class and reliable work which has generally been associated with the name of the British workman. If an attempt is made to cheapen welding at the cost of efficiency, the future of the industry is imperilled and its development will be retarded for many years.

"It is fully realised that all-welded structures will not come suddenly, and for this reason no attempt has been made here to produce, for example, a complete design of such an all-welded ship. Progress must be steady and, it is thought, along the lines indicated herein. It is now recognised by many practical shipbuilders that there are great possibilities in electric welding, and it is to such gentlemen that the author is indebted for some suggestions contained in this paper. At all events, it is hoped that this paper will direct attention to the matter which need by no means be confined to shipbuilding structures."

The President, Dr. Hele-Shaw, in opening the discussion, called attention to the recent performance of the all-welded ship Fullagar which, as stated by Mr. Wall in the main portion of his paper, after eighteen months' service has proved highly satisfactory as regards the welding. The vessel, according to the author, has carried several cargoes of steel plates and similar material and has encountered very heavy seas without showing any signs of failure in the welded joints. She received a minor indent on her side on one occasion without starting the welding, and was recently examined by Lloyds and found to be in good condition. No strains appeared at the break of the quarter deck, as usually happens with riveted vessels of her class.

Professor E. G. Coker said that he was greatly interested in Dr. Hillhouse's method of strengthening window and similar openings in ships' sides by welding on disc-like doubling pieces at the corners. Two years ago, in a paper before the Institution of Naval Architects, he had recorded the results of optical stress determination experiments applied to a tension specimen pierced with a square hole. Since receiving Mr. Wall's paper a few days ago he had determined the stress distribution in a similarly pierced specimen subjected to pure bending. The investigation was not as yet complete, but some very interesting results had already been indicated. It was found, for instance, that no stress existed along either vertical edge of the hole, and that along the top and bottom edges the tension or compression was substantially constant in amount. These results were greatly different from those recorded for the pierced tension specimen, for in that case the sides of the hole parallel with the direction of pull were subjected to tensile stress of a varying amount, while along those sides at right angles to the pull the stress varied from tension at the outer ends to compression at the centre.

Mr. S. V. Goodall, R.C.N.C., agreed with Mr. Wall regarding the disadvantages of riveting. In warship construction it had two additional disadvantages. In such vessels it was desirable to have a form of construction that would stand up to its work, but that would give way instantly when it failed and not hide

the fact that it had broken. Again, it was necessary to have some means of connecting plates of considerable thickness, and in that respect they had hoped in the cancelled warships to improve upon the use of rivets by adopting electric welding. In warship work, however, they had to provide against not only structural failures but for possible major rather than minor indentations. In that connection electric welding was found to be inferior to riveting. It might interest the meeting to know that in order to expedite the fitting out of H.M.S. Renown for the Prince of Wales, electric welding had been largely used in connection with the laying of the wooden deck boards.

Mr. W. H. Thorpe urged the necessity for experience rather than theory in the matter of electric welding in constructional work. Dealing with the increase of stress at the corners of openings in the sides of ships—the point covered by Professor Coker in his remarks—he suggested that that increase was accompanied by an increased resistance of the metal produced by the restriction placed on its flow by the formation of the corner. Tests showed, he said, that the ultimate tensile strength of an unpierced specimen might be, say, 27 tons per square inch, while if pierced it would be about 45 tons.

Mr. R. Williamson asked the author if he had any information to give regarding the corrosive effect of sea water on electric welds.

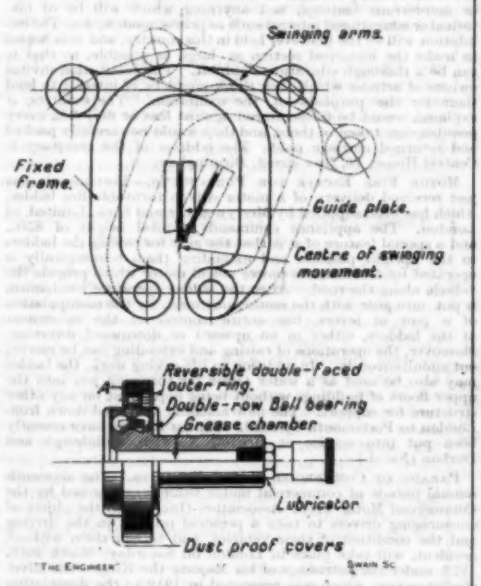
Mr. D. B. Morison agreed with Mr. Wall that the cost of electric welding was greater than that of riveting, but in that matter we were handicapped by the trades unions. A very trying time was still to be gone through by engineers, and it was certain that those engaged in any kind of structural work would hold their own only if they took full advantage of electric welding and all other scientific developments.

Mr. Wall in his reply said that Professor Coker's first example met his case: the second did not. If the ship's hull were regarded as a beam then the window openings were so high up on the side that the material in their neighbourhood was practically under pure tension. He agreed with Mr. Thorpe as to the necessity for following experience rather than theory, but he would point out that what he had said in the paper about the breaking of the material at the corners of holes was based, not on theory, but on experience. Replying to Mr. Williamson, he said that judging from laboratory experiments there was nothing to fear in the matter of the corrosion of electric welds. It was found that the difference of electromotive force between a hammered and an unhammered plate was greater than that between a weld and an unhammered plate. With such differences, modern opinion now associated the liability or otherwise of corrosion taking place.

A Band-Saw Guide.

A FORM of guide for woodworking band saws which has been in use in America for some years, and which is now being manufactured in this country by A. Ransome and Co., Limited, of Newark-on-Trent, is illustrated by the accompanying engravings.

The outstanding feature of the guide is the fact that while it keeps the cutting edge of the saw in a fixed position,



FIGS. 1 AND 2—SAW SWINGING GEAR AND THRUST DISC

the back of the saw is free to swing into the line of the already made kerf, but has a natural tendency to come back to the normal position. When cutting round a sharp curve the saw must, of course, in any case be twisted, but with the usual fixed guide the whole of this twist must take place between the guides, while with the new device the twist is spread out over the whole distance between the saw pulleys, with the result that the saw is far less distressed in the process.

This result is obtained by mounting the actual guides for the saw on a pair of swinging links as shown in Fig. 3. These two links are pivoted to a horseshoe-shaped frame which is fixed to the usual post on the saw. On reference to Fig. 1, it will be seen that the result of the arrangement is that while the saw may be swung out of its normal position, the cutting edge remains practically stationary. At the same time the fact that the saw lies midway between the pivots of the two swinging arms naturally

FIG. 3—BAND SAW GUIDE

tends to bring the saw back into the normal position under the pressure of the cut. The same type of guide is used both above and below the table of the sawing machine.

A new form of ball-bearing disc, of which we give a line drawing in Fig. 2, is embodied in the guide to take the backward thrust of the saw in cutting. The back of the saw bears against the face A of a hard steel ring, as can also be seen in the engraving Fig. 3. This ring is mounted

FIG 4—BAND SAW GUIDE IN OPERATION

on the outer ring of a double race ball bearing specially designed to take end thrust. The inner race of the bearing is formed on the end of a stalk which is clamped in the main casting of the guide and is bored out to form a grease chamber. The relative positions of the thrust ring and the saw are such that the saw rubs right across the face of the ring as the latter rotates, and thus prevents any steps or grooves being worn in the ring. The edge of the ring, however, wears very sharp as time goes on, and seeing that it travels at a high rate of speed and so might give a careless operator a nasty cut, it is provided with a guard. The ring has two wearing faces, so that it may be reversed when one face has worn down to the limit.

Fig. 4 illustrates the advantage of the new guide when dealing with curved work, and clearly shows a good true cut on a board 10in. deep with a ¾in. wide saw working round a curve of 4in. radius. This view also shows how the twist of the saw is spread beyond the guide right up to the pulley.

The Safety of Mine-type Telephones.

A PRELIMINARY investigation has recently been made by the United States Bureau of Mines to determine whether or not the ordinary mine-type telephone is entirely safe in gaseous atmospheres. Two well-known makes of mine-type telephones were purchased for this investigation. It was considered to be not conceivable that the current necessary for talking over telephones could ignite gas. However, the telephones are provided with magnetos, and it was believed that danger might result from the ringing of the magneto. Again, while the type of telephone employed had been designed to have a certain measure of dust and moisture tightness, it had evidently not been designed as an explosion-proof device, either with regard to cover joints and fastenings or strength of castings. It was assumed therefore that owing to the construction of the telephones the gas would penetrate into their interior, and the question was to ascertain whether or not the gas would be ignited from the operation of the magneto.

The telephone under investigation was placed in a large testing gallery of approximately 400 cubic feet capacity, which is used by the Bureau for investigation of all types of electrical equipment in gaseous atmospheres. The gallery is so arranged that it can be filled with an explosive mixture of natural gas and air, the gas being taken from the city mains. The inner and outer doors of one telephone instrument were left open so that the gas could easily enter the interior of the case. The other telephone was placed at a point some distance from the gallery, and connected to the first telephone through a metallic circuit. In series with this circuit was a non-inductive resistance, equivalent to a double circuit of No. 18 A.W.G. copper wire, one mile in length. The telephone inside the gallery was fitted with an attachment which permitted the ringer to be operated from outside the gallery. By another attachment, the receiver circuit could be opened or closed in like manner. The outside telephone could be operated in the usual way.

Tests were made (*a*) by ringing the telephone inside the gallery when filled with gas, but not connected to the external circuit; (*b*) by ringing the inside telephone when connected to the external circuit; and (*c*) by ringing the outside telephone while the receiver circuit of the inside telephone was being opened and closed.

Several series of trials were made with the telephone not connected to the external circuit. They resulted in two explosions, one at the first turn of the crank and one after about one minute. Several series of trials also were made with the telephone connected to the external circuit while the ringer of the telephone under test was being operated. They resulted in one explosion. One series of trials was made by ringing the outside telephone while the receiver circuit of the inside telephone was being opened and closed. It resulted in an explosion. Two series of trials were made with the telephone not connected to the external circuit, and as a result there were two explosions, one taking place at the first turn of the ringer. One series of trials was made with the telephone connected to the external circuit. It resulted in an explosion after the third ring on the inside telephone. One series of trials was made by ringing the outside telephone while the receiver circuit of the inside telephone was being opened and closed, and it resulted in an explosion after one-half minute.

The investigation has, therefore, indicated that the ordinary type of mine telephone as used in the United States is not safe in gaseous atmospheres, and the Bureau has decided that there is need of a specification which shall outline the requirements for telephones that may be called upon to operate in gaseous atmospheres.

PETROLEUM OIL REFINERY IN THE PUNJAB

ON February 11th, Sir Edward Maclagan, the Governor of the Punjab, opened at Rawalpindi a petroleum oil refinery belonging to the Attock Oil Company. Mr. B. T. Petley, a member of the company's home board, in the course of his speech inviting the Governor to perform the opening ceremony, said that the operations of the Attock Company, which was formed in 1914, were at first of a prospecting nature, and that they resulted in the same year in the discovery of an oilfield at Khaur, some 42 miles south-west of Rawalpindi. That territory, he said, had since been exhaustively tested and the company now possessed twenty-three wells, varying in depth from 250ft. to 2400ft., all of which were yielding a satisfactory production. The company also had further wells nearing production. The refinery at Rawalpindi was capable of dealing with 65,000 gallons of crude oil per day, and was equipped for producing the highest grades of petrol, kerosene and lubricants. It also possessed the necessary machinery for the manufacture and filling of the receptacles. The refinery was connected with the oilfield by a pipe-line 45 miles long and supplies of crude were now being steadily delivered. A siding connected with the railway main line afforded facilities for the transport and distribution of the refined products, which would shortly appear on the market. By March the process of refining and distribution would be in full operation.

THE annual show of the Royal Agricultural Society of England will be held at Cambridge from Tuesday, July 4th, to Saturday, July 8th, inclusive.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE BUXTON BOILER EXPLOSION.

SIR,—Being one of the many technically interested in this case, and not in the least wishing to criticise or challenge any item in the report you publish in the current issue of THE ENGINEER, I would suggest that one aspect of the matter has perhaps not received the attention it deserves.

Inaction of the two safety valves appears to be blamed, and the reason for that sought in too little clearance of the valves within their seating bushes. Looking at the construction of these valve pairs as far as the small-scale drawing you reproduce permits, it will be granted that to enable one or both valves to rise, the spring-loaded lever holding them down must be absolutely free to respond. However free the valves may be in their seatings they cannot act if a simultaneous vertical movement or rocking movement of the holding-down lever is prevented, and in the latter case one valve would simply lock the other all the firmer, such action being mutual for the pair. The possibility of some obstruction producing absolute immobility and locking of the valve lever is, to my thinking, by no means a far-fetched idea, and perfect freedom to movement of the valve lever seems to me just as important as free movement of the valves themselves within their seating bushes.

ALBERT ALFRED BUSS.

Manchester, February 20th.

[Of course, sticking of the mechanism would have the same effect as sticking of the valves, but no evidence could be found that it had occurred.—ED. THE E.]

SIR,—Your comments on the Buxton boiler have interested me quite as much as the report, especially the query as to the ability of a sticking valve to withstand an excess pressure, and, as you remark, it is all a question of dimensions obtaining at the time.

I beg to suggest that as a general rule it is not always realised how much deadweight is required to start a cylindrical—admittedly not a parallel case—body out of a hole.

I remember some years ago having to withdraw a bush well under 2in. diameter from a hole in a sleeve, whose shape and the packing available precluded setting the work in a Greenerd arbor press, which stood on, and was bolted down to, one end of a heavy lathe bed, exactly under the queen post of a new wooden roof truss, carrying a good boarded slate roof and line shaft and pulleys. Being in a hurry, the job was packed up on the floor under the press, and the press was shored down from the tie beam overhead. An attempt to start the bush lifted the tie beam a good 2in., and the whole of that part of the truss, including the press and one end of the lathe bed, and I very promptly desisted, leaving the bush unmoved. But the surprising point was that on going about the job the right way, the bush came out quite easily, and was considered too loose for replacement—yet it had stood many hundredweights of dead load unmoved.

Now to get back to the safety valve. When a winged slack is machined, the wings generally get a little undercut as the tool trues the seating of the slack, and when in place the top ends thus left on the wings are below the inside edge of the seating of the bush, and round the edge of the seat scale can form above the top ends of the wings. Subsequent re-turning of the slack increases the amount of bush length above the top corners of the wings. The force under the valve is applied by degrees and increases in the gentlest and most imperceptible manner. I can believe that if the valves were inclined to be tight they would withstand a great over pressure applied in this way.

The report says: "It is thought that the surging of the water in the boiler towards the fire-box when the engine started gave the slight additional load necessary to start the destruction." Would it not rather come about by the return surge of the water away from the fire-box, giving the crown a chance to increase its evaporation due to the lessened depth of water over it?

London, S.E. 4, February 21st. A. W. READ.

SIR,—I should like to know the object of the two bulges shown inside the columns of the London and North-Western Railway safety valve just below the valve seatings. If the drawing is correct, the front bulge is larger than the rear one, and the front valve could not project $^{5}/_{16}$in. through the bush without jamming on this projection, if it happened to be turned in such a position that one of the wings came in contact with it.

C. F. DENDY MARSHALL.

Guildford, February 19th.

[The bulge appears to be a strengthening ring. Mr. Dendy Marshall's remark deserves serious consideration, but we suggest that if one of the valve wings touched the seat the valve would fail to seat properly. It is worth while observing Mr. Cranwell's remark that the position of the valves in the seats was shown by indications of rubbing, so that apparently they had not turned round.—ED. THE E.]

SIR,—May I venture to suggest that this explosion was due to the presence of an explosive charge of some kind being accidently present in the coal, and being inadvertently shovelled into the fire-box, and not in any way due to excessive pressure of steam or boiler failure? I think the evidence given will support this theory.

February 20th. WARWILL.

[The evidence is opposed to this theory, for there can be no doubt that the crown of the fire-box blew downwards. The reporters make a point of dismissing the suggestion.—ED. THE E.]

SIR,—In your edition of February 17th I see that the practice at Crewe when hydraulically testing an old boiler after repairs was "just to give it its working pressure in steam," and in Major Hall's report on the Buxton explosion he states that the London and North-Western Railway has decided to test up to one and a-quarter times the working pressure in future. On the railways on which I have worked, I believe it is still the practice to test hydraulically up to one and a-half times the working pressure, and it would be interesting to know what is the general practice of English railways when making this test.

Such instructions for the examination of boilers as these of the Great Northern Railway, which you publish, are probably issued on many railways, and they may well include special reference to clearance in the safety valve link, for in the case of the Ramsbottom safety valve, if this clearance is not sufficient, the valve may blow off at working pressure, but be prevented from opening fully.

February 20th. DIST. LOCO.

THE INTERNAL COMBUSTION TURBINE.

SIR,—The instructive comparisons given by Mr. Davey in his letter of your issue of the 17th inst. should give serious thought to all who are anxious to obtain a reduction in fuel waste. Economy may be obtained by centralising the production of energy, on whatever system the conversion of latent heat to dynamic power is carried out. A further undoubted economy can be achieved with the use of internal combustion turbines when the presumption of their efficiency has been demonstrated to be a fact. I have endeavoured, by my remarks upon the vital factors, viz., sub-atmospheric working with or without a super-atmospheric cycle, efficient regeneration of heat, recovery of the exhaust kinetic energy, and the use of a self-compressing "kinetic" pump, to focus attention on the essentials as a whole. Too much depreciation of gas turbine possibilities is based on such points as blade temperatures and high temperature of working parts. These are problems to which modern knowledge can supply solutions.

There is yet another factor to which I have not referred, that is the "refrigeration" of the exhaust gases on exit from the cooler and before entry to the compression pump. In a steam cycle, the negative work of compression is largely reduced by the condensation of the steam. Further cooling is not necessary for reduction of the pump work nor desirable on the ground of efficiency. The hot well temperature should be as high as possible consistent with rapid condensation. The efficiency of the cycle increases with the decrease in vacuum pressure, and every endeavour is made to maintain as high a vacuum as possible. Now, in a gas system there is no prospect of such a rapid liberation of latent heat, and so we must concentrate, not so much on the maintenance of a high vacuum, although that is of great importance within a limit, but on the cooling of the low-pressure exhaust gases. "Refrigeration" as a distinct adjunct of a gas cycle is therefore necessary. By "refrigeration" is meant a depression of the final gas temperature below that of the natural surrounding cooling medium. Roughly speaking, a depression of 10 deg. Fah. will give an increase in overall efficiency of 3 per cent., or an expenditure of 1 per cent. of the Net Work of the turbine leads to an enhancement of power of about 3 per cent. The refrigeration work can easily be obtained from the regenerated heat. There is, of course, a lower limit beyond which this principle cannot be carried. The final temperature of the exhaust gases can thereby be controlled, and they may be released to the atmosphere with an entropy value equal to their initial value. There are other advantages of refrigeration that make it worth deep consideration.

The figure of heat transference per square foot per hour given by Mr. Davey appears to be rather pessimistic. In modern condensing systems in which heat is transferred largely by convection, as apart from radiation, the figure becomes 14,500 thermal units per hour. The steam speed on entry to the condenser is about 460ft. a second, while the cooling water speed is of the order 7.5ft. a second. Steam and water maximum temperature difference about 26 deg. Cent. For boilers where radiated heat plays a much more important *rôle*, a good figure —Kastner boiler—given in your issue of January 13th last is 6800 thermal units per hour, but in locomotive boiler trials a figure of 11,000 thermal units per hour has been reached. In this locomotive boiler trial, one-half of the fire tubes were plugged up, and the total evaporation remained practically constant. So that by doubling the velocity of the flue gases, double the rate of heat transference was obtained. All known data goes to show that increasing the gas and water velocities leads to better conduction of heat. There is possibly a relationship between temperature and velocity that leads to a fixed maximum rate of heat transference, but I think that we may safely assume a value at least five times that given by Mr. Davey. It is also tacitly admitted by Holzwarth that increased heat transference can be obtained over current boiler practice. This assumption will give a length of regenerator tube certainly not more than 8ft. at the outside, and possibly less. I have gone into this point rather fully, as it is an important one in sub-atmospheric working.

The investigation of the gaseous friction of Mr. Forbes given in his letter of the 10th inst. is most interesting, showing as it does that an enhanced velocity at low densities should not increase the frictional losses as is always feared. There is room for much experimental work on friction at low densities and high velocities that will be of the utmost value in future.

HENRY A. HEPBURN, B.Sc. (Eng.), Lond.

Birmingham, February 21st.

HOT AIR FOR COMBUSTION.

SIR,—I have read with interest Mr. George E. Tansley's letter in your current issue, and cannot think that he had read the article mentioned in your footnote or he would not accuse all advocates of air heating of taking such a narrow view in comparing the economiser and air heater. Every scheme demands careful study, and the economic proportions of steam-raising plant are greatly affected by methods adopted outside the boiler-house. Turbine "bleeding," evaporators, &c., and the extent to which hot feed is recovered, are all reflected on the dimensions of the recuperative apparatus, whether economiser or air heater.

My letter in your issue of January 27th dealt fully with some of the technical points raised by Mr Tansley. The reason for a lower boiler exit gas temperature with air heating is not difficult to see. Mr. Tansley states the opposite effect. This has bearing on his point (3) in which he overlooks an important factor, leading to a false deduction. The boiler efficiency in the case quoted would be increased with heated air. The gain is not represented simply by the British thermal unit returned with the air. Further, thermal efficiency figures are not sufficient without some indication of capital cost, and I think even Mr. Tansley will admit that for equal capital expenditure more heat units can be transferred to air than to feed water. In other respects, I think his remarks under this heading are fair criticism when applied to high-duty water-tube boilers.

One can well appreciate Mr. Tansley's feelings *re* the economiser, which has truly justified its existence and development, as much as any item in steam-raising plant. I refer to the classic apparatus invented by Green, and which most steam plant engineers will learn with pleasure can be installed with safety in the modern central station, in spite of the high pressures in vogue. An economiser specialist—Mr. D. Rushworth—recently explained at a meeting of engineers what was being done in this direction, and more might be heard of it with advantage. The absence of scraper gear might also be turned to account, to the extent of 2 per cent. economy.

Personally, I agree with Mr. Tansley that in the modern central station there is room for both economiser and air heater, and frequently advocate this on the grounds of both efficiency and capital cost.

Re the other remarks of your correspondent, I fear he has adopted the methods which he set out to criticise. He refers to the short life of air heaters and to rejected installations. Cases are not unknown of economisers having a life only half that of certain air heaters, but if one got all the facts they could trace it to the abuse of the economiser. Such extreme and bald statements are never convincing, and as regards rejected air heater installations, many of us remember superheaters being rejected, but that did not prove superheating was wrong. It showed that we had yet something to learn about lubrication, stuffing-boxes and joints. We continued our studies. The same applies to air heating, and it is no information to hear that So-and-so used it umpteen years ago, and failed. If any particular fire-grate or automatic stoker is not equal to the strain, then the makers concerned had better get a move on, or get left; as the client will employ others with a definite guarantee attached—and there are many available.

S. UTTING, M.I. Mech. E., A.M.I.E.E.

London, S.W. 1, February 21st.

POWER ECONOMY.

SIR,—In the Leader of your February 10th issue you state that on the basis of the large power station generating a unit of electricity on 2.71 lb. and for the smaller stations 6.42 lb. (average figures) that the justification for the big station is made manifest. This does not agree with your statement a few lines further on, when it is pointed out that the best out of 463 stations is a small one, which by the use of producer plants and gas engines generates electricity with 1.7 lb. anthracite per unit, and even based on the thermal efficiency cannot be beaten by the large power station in Durham. This shows the advantages of gas engines to a most striking degree.

That this result can be obtained from a small station again raises the question of the advantages of the large power stations with the cost of expensive cables to districts some distance away. It is said that it is due to the cost of cables, &c., that the charge for electricity for lighting in Manchester, with its large power stations and modern plant, is 7½d. per unit. It would be interesting to see capital cost per kilowatt shown on the large steam power stations to obtain these results.

With regard to reliability, breakdowns occur on large and small units, either steam or gas, but for a smaller station the district affected is not so large.

"And now what of the future?" We need not look so far ahead to consider a new source of energy, and thus obstruct the view of energy immediately at hand. There are in this country about 300 blast-furnaces, from which about 1,000,000 brake horse-power should be available, and of which only a few per cent. is now used. Up to the present time, this gas has mostly been used in a very inefficient way or blown to waste. At the present time, when so many blast-furnaces are out of operation, I believe these could be used as primary producers (coke-fired), and even then show a great saving over many of the large power stations.

J. JONES.

Dukinfield, February 16th.

FOUNDRY EXHIBITION.—In connection with the Foundry Exhibition to be held in Bingley Hall, Birmingham next June, the Institution of British Foundrymen is arranging a section of historical foundry exhibits to include examples of cast iron work or non-ferrous castings, and anything which will be of historical or educational interest such as prints, models, &c. The exhibition will be the first ever held in this country, and it is hoped to make the historical section as large as possible, so that it can be a thorough educational exhibit. The Institution invites owners of articles which they think might be of interest to lend them for the purposes of the exhibition. The exhibits, it explains, would be fully insured against loss or fire, &c., every possible care taken of them, and they would be carefully packed and returned carriage paid. The address of the secretary is Central House, 75, New-street, Birmingham.

MOTOR FIRE ESCAPE FOR PORTSMOUTH.—Portsmouth has just received delivery of a motor driven turntable fire ladder, which has been supplied by Merryweather and Sons, Limited, of London. The appliance commands a total height of 85ft., and a special feature of it is that the gear for raising the ladders to the upright position and extending them telescopically is operated by the 65 horse-power petrol motor which propels the vehicle along the road. After the ladder operating mechanism is put into gear with the motor, one man, by the manipulation of a pair of levers, has entire control of the movement of the ladders, either in an upward or downward direction. Moreover, the operations of raising and extending can be carried out simultaneously. In addition to life-saving work, the ladder may also be used as a water tower for throwing jets into the upper floors of buildings without being dependent on any other structure for support. The new machine travelled down from London to Portsmouth by road. Similar ladders have recently been put into service at Bristol, Norwich, Edinburgh and Durban (Natal.)

PARADE OF COMMERCIAL MOTOR VEHICLES.—The sixteenth annual parade of commercial motor vehicles, organised by the Commercial Motor Users' Association (Inc.), with the object of encouraging drivers to take a personal interest in the driving and the condition of their vehicles, and to run them without accident, will take place in London on Saturday, March 25th, 1922, under the patronage of his Majesty the King. The silver challenge cup, which was presented in 1910 to the Association by the proprietors of the *Commercial Motor*, will again be awarded to the owner whose "team," in the opinion of the Judges' Committee, is in the best condition, having regard to the class of work upon which the units are employed, the ages of the machines, and the total distance run by them. The driver of each vehicle in the winning team will be given a cash award and a silver medal as a souvenir of the event. The drivers of each vehicle in the "runners up" and third, fourth, fifth, sixth, and seventh teams will also receive cash awards, and drivers of each vehicle in the eighth, ninth, tenth, eleventh, and twelfth teams will be "highly commended." Full particulars of the parade may be obtained on application to Mr. F. G. Bristow, F.C.I.S., general secretary, the Commercial Motor Users' Association (Inc.), 50, Pall Mall, London, S.W. 1.

Rotary Converters and Railway Electrification.*

THE successful electrification of railways depends to a large extent on the supply of power at low cost, thus making it essential for the power to be generated in stations having a high load factor. It follows that it will be advantageous in this country for the frequency of the supply to railways to conform to the standard frequency of 50 periods per second, except when the railway will pass through districts in which the frequency has been decided by the large developments that took place prior to the standardisation of a frequency of 50, in which case it would be advantageous for the railway supply to conform to the frequency of the district. Converting apparatus will therefore be required to operate from generating stations supplying power at frequencies of 25, 40 and 50 periods per second, and will probably deliver power to the trains at a direct-current pressure of 1500 volts. Abroad, requirements may demand an operating pressure of 3000 volts (direct current).

Converting apparatus for railway sub-stations, in addition to being economical in first cost, maintenance and floor space, should preferably possess the following characteristics :—

It should be highly efficient.

It should be capable of carrying large overloads, more especially if situated in outlying sub-stations.

It must be reliable and not likely to be put out of

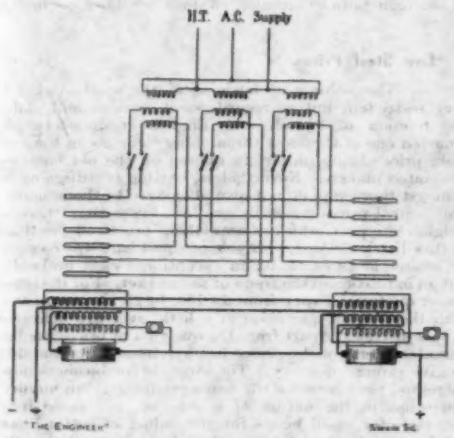


FIG. 1

commission by ordinary overloads and short circuits incidental to railway working.

The direct-current voltage should be as free as possible from ripples and undulations, so as to avoid interference with telephone and other communication circuits.

The power factor should be high, preferably unity or leading at loads above three-quarter load, so that the voltage at the sub-station and surrounding district will be maintained at as constant a value as possible.

The direct-current voltage should be maintained at a reasonably constant value up to heavy overloads.

It should be capable of being built for operation on systems of 25 to 50 periods per second, whether from local supplies of 6000 to 10,000 volts or from extra-high-tension feeders at still higher voltages, with practically equal efficiency.

It should be suitable for the application of automatic control.

It should be simple to operate and capable of being started up and connected to the direct-current bars in a short time.

The rotary converter has become the recognised conversion unit on 600-volt railway systems operating from 25, 33 and 40-period systems, and this paper was written with the object of showing how far the modern rotary converter specially developed for the more exacting requirements of 1500-volt direct current is capable of fulfilling these conditions of service even when operating from 50-period systems.

THE EFFECT OF FREQUENCY AND DIRECT-CURRENT VOLTAGE ON GENERAL DESIGN.

There is a practical limit to the average voltage that can exist between adjacent commutator segments, so that the number of segments between the positive and negative brush arms will increase with the direct-current voltage to be generated. If we assume a minimum width of commutator bar and mica, the distance between brush-arm centres will increase with the voltage. A commutator bar moves from one row of brushes to the next row of like polarity, *i.e.*, two complete pole pitches, in one period, so that for a given distance between brush centres the peripheral speed of the commutator will increase proportionately to the number of periods. Thus the distance between brush-arm centres and, therefore, the peripheral speed of the commutator, will increase with the direct-current voltage, and, further, the peripheral speed of the commutator will increase with the number of periods.

The maximum direct-current voltage that can be conveniently generated in a rotary converter with a single commutator is approximately :—3500 volts for 15 periods per second ; 2000 volts for 25 periods per second ; 1500 volts for 33 periods per second ; 1300 volts for 40 periods per second ; 1000 volts for 50 periods per second.

So that, while on 25 periods the generation of 1500-volt direct current has been accomplished in single-armature converting units, and such practice can be extended up to approximately 33 periods, above this frequency it is necessary to connect two 750-volt rotary converters in series, or one single-unit motor converter could be used for such duty, as in that case the frequency to be taken in the above formula is that of the armature of the motor converter and not that of the supply. In the case of series connection of rotary converters, the capacity of each machine will be half that of the complete unit, and the machine will be supplied from a separate winding on the secondary of the transformer—see Fig. 1. Providing the complete unit is of about 1200 kilowatts capacity and above, there is little to be said against series working, but below this capacity the individual machines become too small for the satisfactory generation of 1500-volt direct current. The series connection increases the floor space required per kilowatt, and this may be a limiting condition in some cases, but in other cases it may be advantageous on account of the reduced weights of each part.

The generation of 3000-volt direct current will generally be associated with a supply frequency of 50, and probably with relatively long alternating-current transmission. For such duty the synchronous motor generator set is the most serviceable unit. The voltage of 3000 could be generated on one commutator, providing the frequency of the generator were kept down to about 15, but this would lead to a costly unit. It will be found more economical to generate such a pressure by connecting two 1500-volt generators in series, each generator operating at about 25 periods per second.

THE EFFECT OF 1500-VOLT DIRECT CURRENT ON THE DETAIL DESIGN OF CONVERTERS.

The general proportions of both 25 and 50-period converters will not be seriously changed with the increased voltages ;

A larger number of conductors of smaller section will have to be accommodated on the armature ;

Increased space will be required for insulation ;

Creepage distances will be increased ; and

The peripheral speed of the commutator will be higher.

These modifications will no doubt lead to slightly larger dimensions for the same rating and speed as compared with, say, 600-volt machines, but the general operating characteristics, such as commutation, efficiency and power factor, will remain unchanged. A limiting condition, however, in railway working is that of short circuit, and, no doubt, precautions will have to be taken in the design of apparatus for the higher direct-current voltages if perfectly satisfactory operation is to be maintained. The liability to flash over is to some extent controlled by the detailed design of the machine, but even when the most conservative figures for design are used, high-voltage machines will flash over when subjected to short circuits, if protected by the ordinary type of switch-gear.

Owing to the energy of reversal in the short-circuited coils becoming too large, the saturation of the commutating flux path, and the high current density under the brushes, if the load on a converter is increased beyond a certain limit, serious sparking results. Also, if large loads be very suddenly applied, the normal balance between alternating-current and direct-current armature reaction is upset and this tends to produce sparking. Under partial or complete short circuits the machine has momentarily to withstand currents beyond the commutating limit, and the armature reactions are seriously unbalanced. This results in an arc being drawn between the commutator segments and the brush tips and adjacent metal parts. While the short circuit remains on the machine the terminal voltage is very low, but quantities of highly conducting vapours are produced. As soon as a circuit breaker disconnects the external short circuit and allows the voltage around the commutator to increase, an arc strikes through this conducting vapour and forms a local short circuit around the commutator. This short circuit again reduces the voltage and the arc is quenched. The voltage again increases, and, if sufficient conducting vapour be still present, the arc will again strike.

This successive striking of the arc may continue, especially on high-voltage direct-current machines, until the alternating-current side is tripped out and the speed and field have been reduced by successive flashes. The striking of the arc through conducting vapour produced under short circuit is generally referred to as "flash-over," and results in damage to the commutator surface and brush gear. The explosive nature of the flash is also likely to force the copper vapour inside the armature and between the field spools, thus causing subsidiary earths and short circuits which sooner or later result in breakdown. Such operation is likely to prove a serious limit to the generation of high-voltage direct current with the ordinary type of apparatus.

It would seem necessary either to modify the normal design so as to make machines more self-protecting, or to provide additional apparatus for the purpose of protecting the machine. No doubt both methods can be utilised with advantage. Manufacturers who have had experience with the design and operation of high-voltage direct-current machines have approached this matter in various ways, and I propose to outline the process of development followed by the firm with which I am connected. Three 800-kilowatt 1500-volt rotary-converter equipments were originally supplied to the North-Eastern Railway for operation on the Shildon-Newport electrification, from the local supply system at 40 periods. Each unit consisted of two 400-kilowatt 750-volt rotary converters connected in series. It was recognised that the short circuit conditions, especially in the early days of the electrification, might be severe, and, consequently, the machines were built with a completely insulating and fireproof screen between the commutator and the rest of the machine, so that, in the event of flash-over, the arc would not penetrate into the more delicate parts of the machine. Good clearance was provided between the positive and negative brush arms, and the operating details of the brush gear were well protected.

When originally installed, the alternating side of the machines was protected by a time-limit device with a view to clearing all short circuits on the direct-current side. In practice it was found that these machines would take partial short circuits up to about five times full load without flashing over, but above that point flashing over would result, and on severe short circuits after the direct-current side had cleared, the machines would sometimes flash over again until the alternating-current side cleared. Under such conditions the commutator was blackened and required attention. It was found advisable to reduce the severity of the flash by the use of instantaneous trips on the alternating-current side of the machine. Later, an opportunity was presented for installing a larger set, viz., a 1200-kilowatt unit (two 600-kilowatt machines in series), and various novel features were introduced with a view to making the machines still more robust and self-protecting. The diameter of the commutator was made practically the same as that of the armature, the armature bars being sweated directly into the commutator. With this construction it is impossible for the conducting vapour produced under short circuit to penetrate inside the armature and cause subsidiary short circuits. The armature was provided with a propeller fan just at the back of the commutator, so arranged that it directed a strong blast of air axially over the commutator surface. The direct-current brush gear was completely enclosed inside cast metal brush holders, which are practically immune from damage due to flash-over. Fig. 2 is a sectional view of one of these machines.

The following advantages of this construction have been proved :—

The conducting vapour produced under short circuit is rapidly swept away by the blast of air, thus reducing the chance of flash-over when the direct-current voltage is restored on the opening of the direct-current circuit breaker.

In the case of flash-over the resulting damage is almost negligible.

The arc has not been known to re-strike.

The conducting vapours are blown away from the important parts of the machine so that subsidiary short circuits are not produced.

The short circuit is cleared so quickly that in most cases it is cleared by the direct-current circuit breaker, and the machine is left running on the alternating-current side.

The following features were also incorporated in the design of these machines :—

The distance between the centre line of the armature and the base plate was made as large as possible, so as to give a large clearance between the brush arm and the base plate and provide for air space all around the commutator.

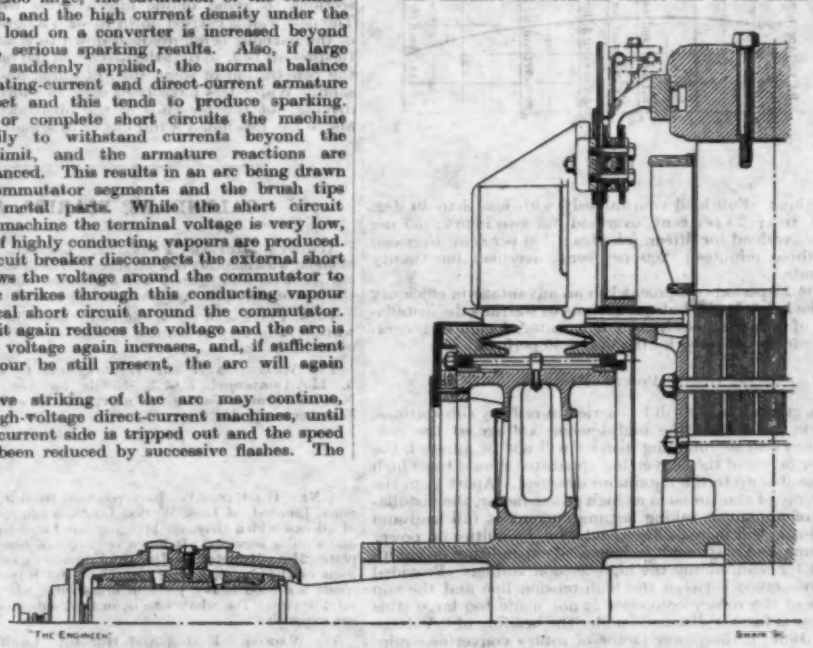


FIG. 2—SECTION THROUGH COMMUTATOR OF 600-K.W. ROTARY CONVERTER

The distance between the commutator and the bearing pedestal was made large, and the pedestal and base plate were shielded with insulation, to prevent the arc striking to earth.

No part of the yoke for the brush brackets projects over the commutator, and this yoke is separated from the commutator and brush brackets by a thick layer of insulating material.

The commutator segments are provided with arcing tips to prevent the deterioration which takes place at the ends of the commutator bars during flash-over.

When on test at the works this machine was coupled to a large turbo-alternator, and loaded up to full load on a water box. It was found possible to "dead short circuit" this machine, clear the short circuit on an ordinary circuit breaker, and leave the machine running on full load. Immediately after several short circuits the machine would carry three times full load with good commutation.

We have recently experimented with a construction for magnetically driving the arc from the commutator surface. This scheme was applied to a 750-kilowatt 1500-volt compensated generator. When protected with an

* Abstract of paper read before the Institution of Electrical Engineers by Mr. F. P. Whitaker.

ordinary type of circuit breaker, it was found possible to short circuit this generator completely when separately excited on the shunt winding, with or without the compound winding, without the slightest damage to the machine.

This construction has not yet been tried out in practice on a rotary converter, but it will no doubt be effective in reducing the damage to the surface of the commutator and brush gear. All the above developments have been in the direction of making the machine itself more robust and self-protecting. The high-speed circuit breaker is a development in external apparatus to protect the machine. The successful operation depends on limiting the period of short circuit and derangement of commutating conditions to such a small fraction of a second that very little conducting vapour is produced around the commutator, and there is little danger of the arc striking when the pressure is restored by the disconnection of the short circuit. It would appear sound practice to construct all high-voltage machines so that they are as self-protecting as possible, and, if the short circuit conditions are severe, the machine should be further protected by a high-speed circuit breaker. Successful operation on 1500-volt direct current has been accomplished with 40-period rotary converters protected by ordinary circuit breakers, and there is every reason to believe that ample margin exists for 50-period working, especially if the protective value of the high-speed circuit breaker is taken in account.

Effect of 1500-volt Direct Current and Frequency on General Performance.

Fig. 3 illustrates the performance that can be obtained from a 1500-kilowatt 1500-volt unit operating on either 25 or 50 periods. In the case of a 50-period supply the unit would consist of two 750-kilowatt rotary converters in series. The regulation, power factor and efficiency curves are based on a conservatively rated unit capable of

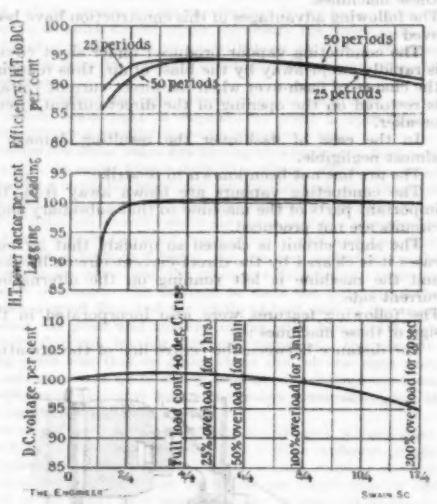


FIG. 3

carrying:—Full load continuously with less than 40 deg. Cent. rise; 25 per cent. overload for two hours; 50 per cent. overload for fifteen minutes; 100 per cent. overload for three minutes; 200 per cent. overload for twenty seconds.

The 25-period equipment has an advantage in efficiency on the lower loads, but not such as to warrant the installation of 25-period equipment if a material gain in generation can be obtained by the use of 50 periods.

Power Factor.

Large peak loads will be carried in railway sub-stations, and in order that the high-tension voltage at the sub-stations and surrounding district will not be affected, the power factor of the converting apparatus should be as high as possible up to the maximum overload. Apart from the economy of transmission at high power factor, the installation of apparatus taking lagging current at full load and overloads will increase the regulation difficulties on power systems, and may result in increased expenditure on equipment for maintaining the high-tension voltage. Provided the reactance between the high-tension line and the slip rings of the rotary converter is not made too large (this matter is further discussed under the heading of "Voltage Variation"), the power factor of rotary converter equipments on the high-tension side can be maintained at unity power factor, even up to three times full load, without appreciable loss in efficiency.

Voltage Variation.

The ratio between the slip ring and direct-current voltages on a rotary converter is practically fixed and can be varied only within very small limits by variation of the field. Reactance is usually inserted between the high-tension line and the slip rings, so that the direct-current voltage can be controlled independently of the high-tension voltage. The amount of reactance is usually defined by the voltage (expressed as a percentage of the alternating-current voltage) that is produced by full-load current passing through the same. The voltage across the reactance is at right angles in phase to the current, and if the current is at right angles in phase to the supply pressure, the voltage produced across the reactance must be either added to or subtracted from the supply voltage.

For ordinary services where the range of voltage is of more importance than the ability to withstand sudden and large overloads without disturbing the commutation of the machine or the voltage of the line, quite large values of reactance may be used to advantage. In railway working, where little advantage is to be gained by the range of voltage or appreciable over-compounding, but where it is advantageous to keep the direct-current voltage as constant and the high-tension power factor as high as possible, and where it is necessary to reduce the momentary derangement of commutating conditions due to sudden loads, it is preferable to install machines compounded to give the same voltage at no load and 50 per cent. overload, with a range of voltage from no load to 50 per cent. overload by shunt control not exceeding + or − 2½ per cent. Under such conditions the reactance can be kept relatively low. Machines designed on these lines would have characteristics up to three times full load, as shown in Fig. 3.

Other sections of the paper are devoted to telephone interference, the wave shape of the primary current, and automatic sub-stations.

IMPROVEMENTS IN LOWESTOFT INNER HARBOUR.

During last year about 600ft. of an old timber quay face at Lowestoft was replaced by the Great Eastern Railway Company by a piled and decked reinforced concrete structure. The work was complicated by the existence of older close-piled timber walls with iron tie rods and anchor piles buried in unrecorded positions behind the replaced quay face. At one section a gap existed in the quay where at some time a slipway had been made. The presence of concealed timber and old iron obstructions caused great inconvenience and difficulty in driving the new piles in correct positions as the new quay face is behind that of the old quay.

The new quay has a face wall 2ft. 6in. high from rail level of the sidings down to the top of the front deck carrying the front siding. This deck is 5in. thick, 10ft. clear span, and is provided with transferse ribs built into a longitudinal front girder under the front wall and into a longitudinal back walling. The front girder is carried by 14in. square piles 40ft. long at 10ft. centres. The back walling is incorporated with a vertical screen wall 4in. thick, about 6ft. high, strengthened by vertical ribs built into a longitudinaly capping beam. The latter supports a "back" lower deck, 5in. thick, 14ft. wide at some 9ft. below the quay level, and is provided to stabilise the structure. The capping beam also unites the heads of a continuous line of 14in. thick sheet piles each 34ft. long. The back deck is carried at the other side by vertical and raking 12in. square anchor piles, 30ft. and 20ft. long respectively, set in pairs at 10ft. centres. The anchor piles are united to the capping beam and screen wall by a deep triangular diaphragm into which the longitudianl ribs of the lower deck are built. Transverse diagonal braces extend from the back of the top deck to the front piles and horizontal braces from the latter run to the capping beam, whilst a continuous horizontal longitudinal lower beam unites the front piles at about half tide level.

The total length of quay face now being reconstructed amounts to 1680ft., and as the site is used for coaling and reconditioning fishing vessels the work has to proceed in sections to avoid undue interferences with this traffic. The new wall is carried down to such a depth as will allow of the harbour being dredged down to a level 10ft. below the present bed, so that the driving of the piles has entailed the penetration of some 10ft. of filling and 22ft. of close sand. Water jets have been used to shorten the time of driving, but the presence of the obstructions mentioned above has precluded a full use of this method of working.

CALENDARS, DIARIES, &c.

August's Muffle Furnaces, Limited, Halifax.—Wall calendar with monthly tear-off sheets. The dates on this calendar are in distinctive figures, and a view of work carried out by the firm or one of its manufactures appears on each page.

Thos. Firth and Sons, Limited, Sheffield.—Blotting sheets with 1922 in very prominent figures, so that no mistake may occur in the date.

The Welin Davit and Engineering Company, Limited, 5, Lloyd's-avenue, E.C. 3.—Refills for the desk calendar. Many illustrations are given of vessels to which these davits have been supplied.

A New Oil Can.—We have received from Joseph Kaye and Sons, Limited, of Lock Works, Leeds, a sample of a new type of oil can which they are bringing out for use on motor cycles and similar services. It has a reservoir of heavily tinned steel plate, 2¼in. diameter by ⅞in. thick, made in two pieces, with a joint of the serrated type typical of the Kaye oil cans. The spout is a good heavy piece of brass tube, which appears to be solid drawn. The whole can is, in fact, substantially made, yet not expensive.

Tip Wagons.—Ruston and Hornsby, Limited, of Lincoln, send us a leaflet illustrating a very substantial form of side-tipping wagon which they are making for use in connection with excavating schemes. It is of standard railway gauge, and tips on one side only. The framing is of hardwood timber, strengthened with steel sections, and its capacity is 4½ cubic yards. The tipping gear comprises three curved rockers, working on three flat-bottomed rails. The body is so balanced that it tips the load immediately the catches are released, but it can be brought back to the loading position by one man.

A New Hacksaw.—A novel type of hacksaw blade is being brought out by Fry's (London), Limited, of 46, Upper Thames-street, London, E.C. 4. It is known as the Enox Twin, and its peculiarity lies in the fact that the teeth at the front end are of a much finer pitch than the remainder. The object of this arrangement is to help the saw in entering the cut and prevent the teeth being broken off before they have done any work. We have tested a 10in. sample, which had about 2¼in. of the fine teeth, and found that it cut very satisfactorily, even when started on a narrow, ragged edge, while its temper compared favourably with the usual type of hard hacksaw.

Re-cut Files.—Two samples of old files which have been re-cut by what is said to be an entirely new process, have been sent to us by the Economic File and Engineering Company, Limited, of Anchor Works, 82, High-street, Bromley, Kent. We are not informed as to the nature of the process employed, but there are indications that a sand blast is used to some extent. In any case, the result is satisfactory. The teeth are keen and very little metal appears to have been taken off the file. The company states that the files are not heated at all during re-cutting, and are thus as hard as when new, while the cost of the process is only one-third of the price of a new tool.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Improved Engineering Situation.

A brighter view prevails in iron and steel circles here, and a representative authority in intimate touch with industrial affairs throughout the Midlands this week remarked that he believed there was more ground for optimism than for some time past. Constructional engineers particularly are more sanguine, for, following upon the pleasant announcement, as recorded by me last week, of the levelling up of steel prices comes the news of the restoration of uniform selling prices for constructional steel throughout the kingdom. That is a matter of considerable importance to this district, for local engineers have found themselves at a great disadvantage owing to the fact that centres like London and Bristol have been what are known as "free" areas, steelmakers being at liberty to undercut prices in those districts. The position was decidedly anomalous, since, in spite of the more costly carriage, local engineers have been charged by Midland steel works as much as £1 per ton in excess of the quotations obtainable by competitors in London. The fixing of a general price for angles at £10 and joists at £10 10s. delivered adjusts the matter to the satisfaction of all concerned. The Scotch steelmakers, who are included in this arrangement, are not expected, on account of the high railway charges, to do much business in this district.

Low Steel Prices.

The volume of business in the steel market is very restricted, but as regards steel sections and plates the reunion of Scotch and English steelmasters has removed one of the most threatening elements in the outlook, prices being uniformly quoted on the old basis by associated makers. Nevertheless, cutting is still going on amongst those who do not own allegiance to the organisation. Steel prices generally are low, lower than those of Belgian shippers, who are now doing practically nothing in this district. An export sale of small bars was recently negotiated at £9 5s. f.o.b., an exceptional case probably, but an indication of the trend of the market. For the home trade, quotations vary from £9 10s. to £9 15s., compared with the Belgian quotation of a little over £10 delivered in this district. Apart from the question of price, English manufacturers get the preference by virtue of their ability to give prompt delivery. The struggle for business now, therefore, rests between the home producers. An inquiry, somewhat in the nature of a surprise, has come from America, for small hoops for the baling of cotton, bars for the reinforcing of concrete, &c. Large quantities of the first-named material were formerly exported from this district, but this was before the McKinley tariff. This business, however, in the event of its being placed, is not expected to come to the Midlands, but to go to firms on the coast, who escape the heavy railway charges. Steel strip is being sold in the neighbourhood of £10 5s., and is more in demand than the more costly iron product. Billets rule at about £7 10s., with an occasional order at from 2s. 6d. to 5s. less. Some sales have been made to Staffordshire re-rollers at £7 5s. A clerical error crept into my steel trade remarks last week, which it is well to correct. I was made to speak of sheets and sections with reference to the advance in West of Scotland prices. My report should have read, of course, plates and sections. The error will have been detected by the bulk of my readers and immediately set right. But I think it best to make the matter plain for all interested.

Staffordshire Bar Iron Trade.

Business remains much about the same as it was last week in the Staffordshire bar iron trade. There is perhaps a slight improvement in inquiry, and the reduction in the price of steel billets has enabled re-rolling to be carried on at some of the ironworks on a small scale. There is little indication that the reduction in marked bar prices has given any impetus to business. In the common bar branch ideas as to prices vary a good deal, for makers appear to be having a free hand. Some well-known manufacturers are still insisting on £12 10s., but merchants have no doubt of their ability to buy at £11 15s., and claim to have bought at even lower prices. The recognised Lancashire figure is £12 for Crown bars, and makers there are stated to be prepared to accept considerably lower than this for nut and bolt and fencing material. It is held that values have declined for this class of bars to anything down to £11. Business is certainly being placed with those firms which offer the best terms, and a good amount of it is being lost to the Midlands and going to Lancashire on that account. There is rather more being done in the fencing trade than is the case with the nut and bolt manufacturers, whose turnover shows no improvement. Small quantities of Belgian bars for nut and bolt making are still being bought, Antwerp shippers quoting much lower rates than home producers. This week supplies have been offered at £9 11s. delivered in the Black Country, whereas the cutters at home have not got much below £11, though consumers are using their power to force the hand of those who are striving to grasp the small orders which are pending. Orders for iron tube strip are on a limited scale, even on the reduced basis of £12 10s.

Lower Sheet Iron Prices.

This week sheet iron prices have seen a reduction of 10s. to £1 per ton. The new basis quotations become, singles £13 5s., doubles £13 15s., and lattens £14 15s. This is the initial reduction this year in the black sheet trade, and follows upon the reduction in the West of Scotland last week of £1 per ton. Galvanised corrugated sheets continue to decline, and on Birmingham Exchange the figure for these commodities is now given as £16 to £16 10s. f.o.b. Some business is stated to have been done at as low as £15 17s. 6d. It is encouraging locally that galvanised sheets make a good appearance in the United Kingdom's

exports for January, 55,560 tons being sent away, as compared with 19,774 tons in 1921. The business is rather slow at present, but some good inquiries are in the market.

Pig Iron.

Makers of pig iron report a little more buying, some rather desirable contracts having been placed within the past two weeks. A fair number of sales have been made, chiefly by Northampton and Derbyshire furnaces, for delivery during the next three months. The export trade has certainly improved, and the inquiries in this direction have included some heavy lots for Belgium. The stiffening tendency in Northamptonshire foundry, under the influence of dearer coke, which I reported in my last week's letter, has been confirmed. It does not appear that the coke suppliers are putting the screw on indiscriminately, though the raising of prices has been sufficient to make smelters uneasy. For forge material the market is very slow, chiefly owing to the depression in the Staffordshire iron trade. Foundry sorts, however, are in better request, and the makers of cast iron pipes are fairly busy and are absorbing good tonnages of this material. In the Derbyshire district the blast-furnacemen have sustained a reduction in wages of 23 per cent. as the result of the recent price ascertainment for the previous three months. It is expected that neighbouring districts will take a reduction of about the same amount. Smelters are getting somewhat higher quotations for coke, and in some districts there are complaints of scarcity.

Engineering Trade Matters.

There has been a further conference of the Engineering Employers of Birmingham and Wolverhampton and the representatives of the Workers' Union and the General Workers' Union, but again no decision has been reached and the conference stands adjourned. The employers are seeking to include in "allied," as apart from purely engineering activities, some seventeen or eighteen trades or occupations. This will mean that wages, conditions and hours negotiations will take place locally, and be settled without reference either to national engineering agreements or national conferences as affecting the suggested list of trades which the employers have submitted. Some 200,000 workers in the area are affected. At the last meeting of the parties, the union leaders said that they would have to consult their members on the two proposals put forward by the employers—the line of demarcation between engineering and allied occupations and the removal of the war bonus of 26s. 6d. per week. In each case the workers' representatives reported that their members were not prepared to agree. The employers intimated that they had definitely decided to set up an allied section of the Federation, and the unions had to consider a revision of wages. The unions failing to come to an agreement on the industries to be included for purposes of local negotiations, the conference was, as stated above, further adjourned.

The Chain Trade.

Some interesting remarks regarding the chain trade of the Cradley Heath and Old Hill districts of Staffordshire and the advent of Spanish competition were made by Councillor B. Millward at a recent gathering at Old Hill. The chain trade is the staple industry of the above-mentioned districts, and it has been severely interfered with by electrically welded chain, owing to which many makers of small chain, said the speaker, had been thrown idle. He was in Spain last year, and upon going into one works there found them making large chain, because, he was informed, it was cheaper than buying it from England. It was being crudely made, but they would improve and would affect the trade in Cradley Heath and district. This area had further been seriously affected by the disarmament policy, and something would have to be found to take the place of those industries which produced instruments of war.

Unemployment.

The unemployment figures for this district continue week by week to show a slight decline, and it is certainly an encouraging sign. Some firms in the Rowley Regis and Halesowen districts are this week reinstating more of their suspended employees, and it is stated that at one establishment overtime is being worked in order to cope with increased business.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

Iron, Steel, and Metals.

THE extreme dulness of the iron and metal markets here is not relieved in any way, although from other districts one gets reports of some signs of improvement. In the gloom of this market it is a little difficult to place faith in such signs, and most people here are in a sceptical frame of mind. It is possible, and perhaps probable, that no very serious fall in prices will take place, and with regard to many principal items we may now be at or near the lowest level; but this does not necessarily mean that any revival of trade is near at hand. With regard to this matter—which is of course of the greatest interest—we may point out that the whole surroundings of the position are entirely new; and that previous experiences of trade slumps do not offer much reliable guidance. Otherwise we should be inclined to anticipate a long and dreary period of inactivity—before the active movement which must eventually arrive.

Metals.

The extreme depression in the copper market continues unabated, and for the first time since January, 1915, the price of standard copper has fallen below £60 per ton. It may perhaps be useful to remember that in the few months before the influence of the war stimulated the copper market, that is in October, 1914, the price of standard copper touched £50 per ton, and electrolytic copper was sold here at £52 10s. Are we to expect a return to these extremely low prices before the reaction in the copper market begins? Of course, some allowance ought to be made for the increase in the cost of production; for if that be taken into account the present prices are quite as low as the lowest of the 1914 prices. The consumption of copper at the present time is very much less than it was then, but this is counteracted by the much lower production. The depressing feature, however, of the present position is that the capacity to produce copper is enormously in excess of the buying power of the world; and a better relationship between these two factors is needed to bring the trade back to a normal condition. With regard to production, it may be pointed out that just as the labour conditions have in the past prevented a reasonable output of lead in Australia, so now there is a prospect of the cessation of Australian copper production from the same cause. The home demand for copper has again been very poor this week, and just now the continental demand seems to be failing. The consumption of manufactured copper and brass is certainly affected adversely by the enormous and unreasonable gap between raw and manufactured prices. Adjustment in this matter is urgently needed, although it might not immediately stimulate the demand. Tin has been again very weak, and some confidence in the future seems lately to have been lost. There is more nervousness as to what the holders of Eastern stocks of tin may do in the near future. There must be a dangerous quantity of tin held back, and it is of course well known that this stock cannot be liquidated except at very heavy loss; but the question is how long can the present holders wait? There is a limit to human endurance; and if that limit should be reached before the consuming trades are able to absorb more tin, the consequences for the market may be uncomfortable. The fall in lead from the highest prices at the beginning of last month is serious enough, and it is of course possible that some reaction may occur, but the feeling in the market is not yet very favourable. Large quantities of metal have been coming in, considerably in excess of any probable consumption, and the inference is that stocks in the country are greatly increased. Spelter remains quiet and dull without any special feature. The demand from the galvanising and brass trades is small, but the Continent is not offering much metal at present.

Pig Iron.

The market here is very quiet for foundry pig iron, simply because ironfounders are doing so little work. If they had much use for iron they would buy more freely now, because there is a chance that prices will be rather stiffer. The reason for this probability is that the strong demand from the Continent for British coke has stiffened the prices of blast-furnace fuel, and taken away any opportunity for reducing the cost of pig iron production. As your readers know, makers of pig iron have been working without a profit for some time, and in some cases at a considerable loss, and will naturally seize any opportunity of raising the prices. One doubts if they will have such an opportunity in Manchester, because most consumers here are in no hurry for supplies of pig iron and could wait for some time before buying. The nominal quotation for Midland No. 3 pig iron to-day is 95s. per ton delivered in Manchester, and the only difference since last week is that there is now no disposition to "cut" this figure. A week ago we heard of buyers getting No. 3 iron at 2s. and 3s. per ton less. In other grades of pig iron there is very little business here. No. 4 forge is much neglected and the price is about 75s. per ton on trucks in the Midlands. Basic pig iron is also very much depressed.

Finished Steel.

There is very little inquiry here for sections steel, and the fixed prices prevent any cutting in the home trade. There is, however, a good deal of competition in the export trade, and low prices are constantly reported. In order to get British prices on a safer level very much more business is required, for in many works the fixed overhead charges bear far too high a relation to the total output. If there were more occupation for the mills the prices both of finished iron and of steel might be reduced to a very large extent.

Scrap.

The market here for scrap is without any fresh feature. Dealers complain very much of the lack of demand, but they keep the prices fairly steady. Heavy wrought scrap is taken by the ironworks at £3 5s. delivered; and the ironfounders buy a little cast scrap at from £4 5s. to £4 15s. per ton, according to quality. Steel scrap is quite neglected.

Manchester Ship Canal.

The report of the directors of the Manchester Ship Canal, to which I referred briefly last week, furnishes in a general way a good indication of the state of trade in Lancashire during the past year. The toll-paying merchandise traffic for 1921 amounted to 3,293,670 tons, compared with 4,387,363 tons in 1920, and 3,589,043 tons in 1919. It was, in fact, less than in any year since 1901. The receipts from this source, however, compare very favourably with those of other years prior to 1919, owing to the increased charges. The decrease in receipts and tonnage was due to the depressed state of trade and shipping throughout the world during the past year, and was emphasised by the general stoppage in the coal mining industry in this country, extending from April 1st to June 28th, 1921. The expenditure in the working of the Ship Canal showed a decrease of £33,543. With the exception of certain minor reductions, wages remained on the high basis which operated for the previous year until August 4th last, when a reduction, averaging about 11s. per week per man, was effected. There was a decrease, as compared with the previous year, in the surplus from the working of dock labour during the year, of £30,020 arising from the decrease in the traffic dealt with. Concurrently with the reduction in wages in August last, the company's charges for labour services were reduced as from August 6th last. The net revenue from the working of the Bridgewater Canals amounted to £29,814, as compared with £10,803 for the previous year. This favourable result is strangely attributable to the curtailing of the carriage of traffic on the Bridgewater Canals which the wages and working conditions of the men engaged therein had rendered unremunerative. Under the terms of the agreement relating to the working of the Bridgewater Canals under the direction of the Canal Control Committee on behalf of the Ministry of Transport, which terminated on August 31st, 1920, the company received £141,156 in respect of "deferred maintenance" to provide for the execution of maintenance, renewal and repair work which it had not been possible to carry out during the period of control owing to shortage of labour. Of this sum, £82,946 has been expended during the past year, and there is a balance remaining in the balance sheet of £58,210 for work yet to be done.

New Work on the Ship Canal.

An interesting development of the Manchester Ship Canal which will shortly be brought into use is the new dock, subway and storage accommodation for petroleum products, including spirit at Stanlow, near Ellesmere Port. The extension of the company's storage warehouses at Trafford Wharf has been completed during the past year, and a contract has been let for the construction of a reinforced concrete wharf, including foundations for transit sheds, adjoining Trafford Wharf-road at the Manchester Docks. The 60-ton self-propelling floating crane was delivered at the Manchester Docks during the past year and is working satisfactorily. It has already proved a valuable adjunct to the equipment at the docks. The total expenditure on capital account up to date is £17,084,000.

The Lancashire and Yorkshire Railway Pioneer Work.

At the last meeting of the shareholders in the Lancashire and Yorkshire Railway Company, which was held in Manchester last week, Mr. E. B. Fielden, the chairman, gave an interesting review of some of the improvements and developments in railway operation which were brought about by this company. Mr. Fielden said that the Lancashire and Yorkshire Company was the first to fit the rolling stock with continuous brakes; the first to instal the block system of signalling throughout the main line, and also, he believed, that the section through Summit Tunnel, near Littleborough, was the first portion of any railway ever worked on the block system by the electric telegraph. It was the first company to light its trains with gas, and the first to complete the equipment of passenger stock with automatic continuous brakes; the first to equip goods engines with continuous brakes; the first to instal telephones in signal boxes; the first to fit the whole of its wagon stock with either-side brakes; the first to provide smoking compartments, and the first to bring into use main line electric traction with its own generating station on the line between Liverpool and Southport.

BARROW-IN-FURNESS, Thursday.

Hematites.

Whilst in North Lancashire there is no change to report, the position in West Cumberland, so far as the production of hematite pig iron is concerned, is improved, and it is expected that on Monday next the Millom and Askam Company will put a furnace into operation at its Millom works. This furnace was damped down just before Christmas. The plant at Askam has not worked for a few years. There is a rather better demand for iron on general account, and inquiries are fuller than for some time past, and it may be that now it is known that iron prices are at the rock bottom, that long delayed orders will be placed. Local steel makers' requirements are fairly good and are increasing in the Workington district.

Iron Ore.

There is only a moderate demand for iron ore and the trade is confined to local smelters. Several of the big mines are still closed down. At the Roanhead mines, near Barrow, an increased amount of ore is being raised, but the Barrow, Steel Company is doing very little mining at present. No imports of Spanish ore have been made into Barrow for some weeks. The steel trade at Barrow remains fairly busy in the rail departments, and last week shipments were made from Barrow of steel rails to Birkenhead for re-shipment overseas. New business is quiet all round. The hoop mills at Barrow continue busy and are using billets from away on account of low cost. Nothing is being done in ship or boiler plates.

Fuel.

There is a very quiet demand for coal, and coke is in limited use on account of the few furnaces in operation.

Shipping.

Last week shipments of pig iron were made from Barrow to Treport, in France, and also to Genoa, besides small parcels on coastwise account. The imports, with the exception of bulk oil, were very small.

SHEFFIELD.

(From our own Correspondent.)

Still Hopeful.

THE best that can be said concerning the Sheffield steel and engineering trades is that those engaged therein are "still hopeful"—but with very little more ground for this confidence than was the case when I wrote a week ago. Certainly there are more inquiries about, but none of the manufacturers admit that many more orders materialise therefrom. At the same time it must be said that for some reason or other the heads and responsible officials of a number of local firms are just now very reluctant to give details of any orders that do come their way. One hears

from time to time that orders have been placed—for railway material, for example—and when the inquiry is made of the firm concerned one is assured that "nothing definite is settled yet," and requested, as a personal favour, to say nothing about it at present. Meantime there is this undoubted fact, that more pig iron is being sent to Sheffield by the North Lancashire and Cumberland ironmasters since they announced, a fortnight ago, that the new price must be regarded as a firm one for many months to come, discounting as it did all past and prospective railway concessions, wage adjustments and coal prices. Now, it may be taken for certain that Sheffield is not buying more pig iron for the purpose of collecting this material. Sheffield Chamber of Commerce, whose leaders include some prominent steel and engineering men—among whom there are few optimists—announces in its monthly journal, just issued, that the heavy trades have seen the worst of their troubles and trials—providing there is not another big coal stoppage. Demands are steadily broadening out, and if prices are not again inflated, the revival movement may be progressive.

Possible Shortage of Pig Iron.

A considerable number of steel furnaces and rolling mills are being re-started. Continental makers cannot materially increase their production, and they are mostly in arrears on current commitments, so that international buyers are turning more to the British market. Chief interest centres round pig iron. The supply of continental iron, upon which our steel manufacturers have so largely depended recently, is drying up. Some shipments of Belgian iron are being made on old contracts, but fresh business is not being booked. The pig iron movement is going to be reversed. Instead of importing pig iron we are about to begin exporting. There is a distinct danger of shortage. The entire make of our most modern and economical blast-furnaces ought to be reserved for our own steel works. As more and more of our furnaces are commissioned, the average cost of production will advance, for the aged furnaces cannot produce as cheaply as the newer stacks. It will be unfortunate if foreign steel makers are permitted to bespeak the outputs of some of our most modern furnaces at current low quotations, and then, when real activity sets in, our own British steel manufacturers have to depend on dearer iron made in the old furnaces. As the demand for steel and engineering products expands, there will be keen competition for pig iron by reason of the limited production on the Continent, hampered as it will be by labour and transport conditions.

Unemployment at its Peak.

Optimistic anticipations would appear to be somewhat discounted by the fact that at the time of writing the unemployment figures in Sheffield—totalling just under 50,000—are the highest since the last coal strike, when they reached 70,000. At the same time it is freely stated that many of the men have been told to hold themselves in readiness for an early re-start. It is interesting to note that the absorption of this big army—larger in proportion to population, it is said, than in any other great industrial centre—is not being left to the blind operation of the law of supply and demand. On the initiative of the Lord Mayor of Sheffield, another conference of Lord Mayors from the towns which have been badly hit by the reduction of the battleship programme has been called, but the date of meeting has been deferred pending an expected announcement of Admiralty intentions. After a preliminary talk with the members of Parliament for the areas affected, it was intended to appoint a deputation to the Government to urge that arrangements should be made to give Sheffield some equivalent work, such as the manufacture of railway material for the Crown Colonies. While on the subject of Admiralty work, it is of interest to note the report that the well-known Sheffield firm of shipbreakers and general engineers, T. W. Ward, Limited, has practically completed negotiations for taking over the naval depôt at Inverkeithing. Messrs. Ward propose to adapt the depôt as a shipbreaking yard. The lease, it is understood, would be for twenty-one years, but the terms have not been disclosed, and a director of the firm will neither confirm nor deny the report.

Price Factors.

Another circumstance that perhaps is more encouraging than unemployment figures is the movement towards stabilisation in prices, both with regard to raw materials and finished products. There is not much change in iron and steel prices generally. The official quotation of iron hoops has been reduced from £16 10s. to £14, but steel hoops remain at £12 5s. as before. Foundry pig iron can be bought here at from £4 8s. to £4 10s., and forge at 5s. less. Hematite has now dropped to reasonable figures such as should encourage buying—and, indeed, as shown in a previous paragraph, has already had this effect. At £5 15s. it is 30s. cheaper than it was three months ago. With regard to steel products, one hears rather less of price-cutting than was the case a short time ago. In finished steel, where the competition was keenest, makers are now disposed to act more in concert. Local billets are selling at from £7 10s. to £9 for soft basic, and £9 to £9 15s. for the hard basic. Siemens acid billets are at £10 to £11.

Cheaper Fuel.

Still another helpful influence is a slightly easier tendency in the coal market. Here also a steadier tone is to be noted, attributable to a slight expansion in inland consumption, together with export business on a rather more active scale than recently. At the same time it is reported that prices for similar quality fuels show very wide variations, according to the position in which the particular colliery concerned is placed at the moment with regard to orders. Where large stocks are in evidence the prices are reduced by the necessity of making forced sales. As far as slacks are concerned, there are still some spot lots to be picked up at special rates, but the selling pressure is not so strong as it was a week or two ago, the improvement in this connection being brought about by the increased demand for coke-making purposes. During the last week or so several batteries of coke ovens have been put into operation, and as in the aggregate they will absorb a very substantial tonnage, it must necessarily have a beneficial effect on the slack market. This additional demand for coke is not entirely caused by increased usage at blast-furnaces, but by the competition for other inland purposes with gas coke, the prices for which are considerably higher.

Pit-sinking Resumed.

Increased coal supplies are promised as a result of the preparations now being made for the resumption of sinking operations at the Markham Main Colliery near Doncaster, which were stopped by the war and subsequently by the industrial situation. It is expected that this colliery will be one of the best equipped in the country. A number of houses forming part of a garden village planned by Sir Tudor Walters are already occupied by miners employed at Bullcroft. There are also in hand operations for deepening the shaft at Pleasley Colliery, North Notts. Black shale has been reached at 1203ft. from the top hard seam, or 2745ft. from the surface. It is not anticipated that winding from the deepest seam can be commenced this year, one cause of the delay being the amount of water which accumulated in the shaft bottom during the strike of last year.

Britain's Coal Reserve.

The enormous development of the South Yorkshire coalfield (including North Notts and Derbyshire) was described by Professor Kendall at the annual dinner of the Yorkshire branch of the National Association of Colliery Managers, of which Mr. J. Ensor, of Tinsley Park Collieries, Sheffield, is President. Professor Kendall (who is about to retire from the University of Leeds after thirty years' service, much of which time has been devoted to coal mining research, and during which period he has delivered 10,000 lectures), said this coalfield was the great coal reserve of the British Isles. Since 1900, 225 square miles of coalfields had been brought actually into operation; pits and sinkings had been developed into an additional 94 square miles, and 154 square miles had been leased, making a total of 470 square miles of coalfields leased or developed during the last twenty years. There was, he said, no other coalfield so capable of development. Mr. W. Hargreaves, President of the West Yorkshire Coalowners' Association, said, on the same occasion, that they were bringing down the price of coal to such a point that they hoped it would command the markets and bring about a revival in trade.

Opposition Gas.

So strong is the resentment aroused by the Sheffield Gas Company's application for parliamentary powers to fix 9d. per therm as the basis price (something like four times the pre-war charges for industrial purposes) that it is seriously suggested that manufacturers should combine in a proposal to install producer gas plants, and distribute the supplies from them by mains along the streets. Of course, powers would have to be obtained for this work, and it would be interesting to see if the Gas Company would offer opposition to it and attempt a justification for its proposed new charges. At any rate, manufacturers whose annual consumption of gas—and in cases where it has hitherto been used in metallurgical furnaces this is very high—would warrant it are seriously considering the provision of producer plant for their own purposes, and there is no doubt that in many cases this scheme could be carried out economically. Meantime the annual report of the Gas Company, which has just been issued, shows that last year the cost of manufacture totalled £226,804 less than the previous year. The total quantity of gas sold during the year was 13 per cent. less than in the previous year. When it is remembered that the supply for domestic use actually increased, it is clear that gas for industrial purposes is rapidly falling out of favour. The receipts from the sale of gas dropped by nearly £80,000, and from the sale of residuals the decrease was £129,000. The company's coal bill, on the other hand, was £50,000 less. It is interesting to note that the little Lincolnshire town of Spalding—many miles from the nearest colliery—can suuply gas at 4s. 2d. per 1000 cubic feet, which is only 6d. more than the cost of Sheffield gas

A New Alloy.

Particulars of the new alloy, which is claimed to possess stainless properties comparable with those of stainless steel, have now been published. As recently stated in this column, this new alloy can be produced very much more cheaply than stainless steel, and while suitable for spoons, forks, and other table ware and hollow ware, is not hard enough for cutlery purposes, as will be evident when it is stated that its composition is 64 per cent. copper, 35 per cent. nickel, and 1 per cent. tin. The new alloy is now being supplied in considerable quantities to a number of local firms, who have taken up its manufacture into a large variety of articles of household utility. It is said to be very durable and to retain its colour under the most trying conditions.

Water for the Fens.

Few people would associate Fenland with a water famine, but the recent drought proved that even in that region of dykes the water supply facilities are inadequate, and that many of the smaller towns and villages and farms suffered severely. The local authorities are now seriously considering this question, and Spilsby Rural District Council contemplates a scheme that will supply about a dozen little towns scattered over a wide area, involving an expenditure of something like £33,000 and 25 miles of mains. The Council has entered into an agreement to purchase an existing pumping station, reservoir, and mains supplying a portion of the district. It is proposed to utilise water from the green sandstone near Spilsby, where during the drought it was found that about 180,000 gallons were running to waste each day. Besides providing drinking water for domestic purposes, it is proposed to give a suitable supply for the cattle during times of drought when the dykes are tainted with sea water.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

THE position of the Cleveland iron trade has broadened out considerably, and has become distinctly encouraging. A great deal has, of course, yet to be done before anything like a normal position has been reached, but there are definite indications of better times ahead. The position of the pig iron makers has undergone a swift transformation. A few weeks ago they were searching anxiously for orders; now their make has been sold for weeks ahead, and some firms are not in a position to sell any more iron till April. The home foundries are getting more work from the engineering works, and this reacts favourably upon the pig iron market, and although Scotland is still importing a certain amount of foreign pig, Cleveland iron is going there in increasing volume. In this connection it is interesting to note that for the first time since December, 1914, the shipment of Cleveland pig iron from Skinningrove has been resumed. But it is not merely in the home trade that the demand is expanding. The demand from the Continent is also rapidly improving, and the February shipments abroad are on a much more substantial scale than for months past. It is chiefly hematite that is wanted, but there is a good demand for Cleveland iron also, and it is clear that this district is once again regaining a foothold in the markets hitherto closed to us. Under such encouraging circumstances the possibility of further furnaces being lighted up is again brought into the foreground. One at least is expected to be put into operation in a few days. But the chief obstacle to a revival of activity at the ironworks is the fact that even now the cost of production exceeds the selling price. Ironmasters naturally hesitate to increase output if it merely increases their losses. In this respect the rising of coke is a serious factor, and some makers freely hint at an early advance in prices. Hematite is, in fact, already dearer, but for the time being, at all events, Cleveland prices have been kept unchanged, the quotations either for home consumption or for export being: No. 1 Cleveland and siliceous iron, 95s.; No. 3 G.M.B., 90s.; No. 4 foundry, 87s. 6d.; No. 4 forge, 82s. 6d.; and mottled and white iron, 75s.

Hematite Pig Iron.

Some substantial parcels of hematite pig iron have been sold to Italian buyers, and Belgium is also buying pretty freely. There is a wide variation in prices, but a fair average price for East Coast mixed numbers seems to be 97s. 6d. per ton, and for No. 1, 98s. 6d. Possibly a little iron could be got for 96s. per ton, where prompt delivery is not a necessity, but others quote as high as 100s., and some are not prepared to name any prices whatever.

Iron-making Materials.

The foreign ore trade is very quiet. In the first place nobody will buy ahead, and in the second place there is a very limited consumption. Best Rubio ore, which is still regarded as the standard quality, ranges from 26s. to 26s. 6d. per ton c.i.f., but the less conservative iron smelters, who are prepared to use other ores, can buy them at shillings per ton below the price of best Rubio. It is only possible to indicate an average price for furnace coke. Inferior qualities can be bought as low as 28s. per ton, but good qualities command 30s. per ton delivered at the works—a price far too high for the ironmaster to pay.

Manufactured Iron and Steel.

No changes have occurred in manufactured iron and steel prices, but there seems to be just a little more inquiry, and a few orders have been placed for railway material. The general position of the trade, however, is very discouraging, practically all the mills working being on short time.

The Coal Trade.

The Northern coal trade has lost none of its recent strength, and there appears to be no present indication of any alteration in values. The inquiries from the usual sources continue to be numerous and heavy, but there does not appear to be any considerable bookings going forward. Many of the exporters are already committed to considerable quantities, and many of them have been badly caught by the present sudden enhancement of values, and are not likely to proceed further until there is a much more settled and stable tone. There continues to be a great diversity of opinion as to the probable duration of the present boom. Many think that the present inflated figures represent no more than a passing phase, while others are equally convinced that high prices will rule for a little while longer at least, so that for the present nearly all the trade being done is for prompt or early loadings. There are numerous feelers respecting the April possibilities, but it is doubtful if any of the present quotations would be paid for that date. The position, however, appears to indicate that maximum prices have been reached, and some are of the opinion that there will be an easement in the near future. In any case there is no room for doubt that if values continue to ascend there will very soon be a decrease in the amount of overseas business. This would be unfortunate, as it is on the export trade that the prosperity of the Northern coalfields depend, in addition to the commercial and shipping interests. For this month or early March, there is nothing to be had direct from the collieries, and even in second hands the supplies are limited, and very dear. The output in both counties has increased since the influenza epidemic subsided, but for any spot parcels available there is very keen competition. Coke of every description is in heavy demand, and the prospects point to possible further advances.

SCOTLAND.

(From our own Correspondent.)

Greenock Development.

SOME time ago land was acquired at the James Watt Dock, Greenock, by the British Oil and Cake Mills for the erection of an oil and seed-crushing mill. Good progress has been made with the construction of dock sheds, and the company is now in a position to commence work on the main buildings, plans of which have just been submitted to and passed by the Greenock Dean of Guild Court.

Pig Iron.

Recent rumours suggest a little more movement in pig iron, but the progress made must be very slight. Most producers are quite ready to put their furnaces into operation, but ever since the last coal strike business has not warranted anything beyond the absolute minimum of activity. One large concern with only one furnace in operation is quite able to satisfy all its orders at present. Prices still show a declining tendency, and it is questionable if there is any margin of profit. Considerable losses would have to be covered, as only recently have makers been using ores secured at to-day's market price.

Steel and Iron.

The steel and iron markets remain, more or less, in a state of stagnation. Consumers, both at home and abroad, are evidently convinced that to buy only for absolute requirements is the policy to follow at present, and that by so doing cheaper prices will be obtainable in the long run. The Steel Association has again come into being for the control of prices. Steel for export has been quoted 30s. to £2 per ton below home figures, but is now inclined to firm up. Plates and sectional material are in poor demand. Sheets show a little movement. Home and near export markets are not active, but Far Eastern consumers are buying in fair quantities. Signs of increasing business in sheets are said to be more prominent, and perhaps the recent reduction in prices may help matters. A more hopeful feeling also pervades the light and heavy castings departments and also the tube trade. The engineering works generally are not making much progress. During the past week or two the bar iron market has had more export inquiries, but the home trade remains dull. One or two steel works have announced a partial re-opening, but the effect on unemployment is trivial.

Coal.

The outlook in the coal trade is a little brighter. The demand for washed materials is maintained in all districts, and during the past week the West of Scotland collieries have booked a few good export orders for splint coal. It is hoped that this movement will soon extend to other qualities of round coal. Fifeshire and the Lothians are comparatively well booked up for round coal. Though export orders are fairly numerous shipments have been held up through delays caused by bad weather, and also by steamers being ice-bound in the Baltic ports. The aggregate returns for the past week amounted to 208,095 tons against 241,607 tons in the preceding week and 298,943 tons in the same week in 1913. Household coal is in good demand at present. It is hoped that now that the Scotch railways have granted small concessions for the carriage of coal to blast-furnaces and steel works, still further reductions will be granted and made applicable to all classes of consumers.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

REFERENCE was made a week ago to the better state of the coal market, but it is to be doubted very much whether many exporters or coalowners ever expected that the market would improve to the extent that has been the case. The tone has not only been maintained, but has become stronger, and compared with its condition of a fortnight ago prices of large coals are anything from 1s. 6d. to 2s. higher, and there is a very good prospect of them continuing at their present level. Colliery stems are very full, not only for the remainder of this month and the early part of next, but in many cases order books are pretty full for the whole of March, and in the view of colliery salesmen the outlook up to the Easter holidays is practically assured. This remarkable change as compared with the conditions of a few weeks ago will no doubt seem extraordinary, and has surpassed all expectations, but it is the old story of buyers generally waiting for the market to touch bottom and then coming in together to find that prices rebound. Some speculative middlemen engaged in the export trade who are interested more especially in shipments to Italy have recently had a bad time, and they are not at the end of their unfortunate experience. Some people have all along been disposed to severely bear the coal market, and although these tactics have succeeded up to a few weeks ago, when coalowners really set their faces against further reductions, since then the position has been reversed, as they have had to go to the collieries to cover themselves for the sales which they had made to buyers abroad, and, in addition to having to pay a higher price for their supplies, they have not found any consolation or compensation in the outward freight market for West Italian ports, which, instead of weakening, have advanced under the demand for prompt boats, and the fact that tonnage is now becoming far more distributed over the globe. It is calculated that some of the business which has been arranged within the past month or two is now turning out disastrous for the speculators concerned, to the tune of 4s. or 5s. per ton, which is a very serious matter. So far as can be seen, the inquiry for South Wales coals promises to continue. Inquiries are not for large quantities, the only one of any note for which tenders had to be in on Monday last being 40,000 tons of best Admiralty double-screened large coals for the Norwegian State Railways, for shipment over the next few months. This same inquiry is in the market for North Country coals, and it is not expected that at the most more than a quarter of this quantity is likely to come to this district. But apart from this, the demand from various quarters is extending, and there are more inquiries for single cargoes, from which it is to be concluded that the conditions are becoming more settled abroad, while, furthermore, the tendency of the foreign exchanges is in the right direction.

Colliery Development.

There is no doubt that with the improved trade outlook, coalowners will give more attention to the question of colliery development, and it is to be hoped that one good result will be that unemployment in the coalfield will be reduced to a minimum at an early date. At the same time it cannot be disregarded that if output increases to any marked extent, there is the prospect that docks shipment facilities will again prove utterly unequal to the situation, as has been the case before. The effect of this will be to prevent collieries getting their wagons emptied promptly, and the market will be weakened as a consequence. Whatever the future has in store, it is interesting to note some of the development work that is proceeding. At Llanharan the Powell Duffryn Steam Coal Company have two 20ft. pits in process of being sunk to the gas coal seam, and the old colliery, known as Bryn-y-Coe, which was sunk to a depth of over 150 yards over forty years ago, is being opened out again. It is understood that three pits are to be sunk at Ynismardy Farm, Llantrissant, all of which will be electrically equipped and supplied with power from Bargoed. In the Upper Rhondda the outlook regarding future employment is brighter, as four new shafts are being sunk, and of them, the Cwmpark New Pit at Cwmpark is almost completed. It is calculated that before long there will be employment for about 500 men. The Ocean Coal Company is erecting a huge up-to-date screen. The Tylacoch new shaft at Treorchy is also rapidly nearing completion, and a large washery is also being constructed, and when the developments are finished it is estimated that there will be work for about 1000 men. At Blaencwm and Blaenrhondda, the Glenavon and Fernhill colliery companies respectively have new shafts sunk, and the prospects are regarded as good for the employment of about 2000 men in the future. A big future is predicted for the Ogmore Vale, where Messrs. Cory Brothers are credited with having an extensive scheme in view, which will involve the outlay of a million pounds, this scheme including the electrification of the company's undertakings, which include the Aber, Wyndham and Penllwyngwent collieries and some of their property in the Rhondda. They propose generating their own power with plant at Ogmore Vale, and this will be transmitted to the various collieries by overhead lines. So far as the main distribution at the local collieries and the immediate neighbourhood is concerned, extra high-tension cables are being used for the transmission of the power. Two cooling towers are at work in connection with the main powerhouse, and more are to be installed. Developments by other colliery concerns are also regarded as likely in the Ogmore Vale, and it is calculated that in a few years' time several thousands more workmen will be engaged in that area.

Miners' Federation and Non-unionists.

The fear of an early stoppage of work in the Maesteg area has again been removed, as, on the advice of the leaders, a mass meeting of the workmen has decided to withdraw the notices that were given some weeks ago on the non-unionist question. According to Mr. Hartshorn, the President of the Federation, the position at the lodges is that, with the exception of four, all the men are now paying members of the Federation. At the four lodges in question there are eighty-four men in arrears or out of compliance and seventy-six men are in the new Craftsmen's Union. Steps are to be taken to hold a meeting of the craftsmen to see if it is not possible to get these men to rejoin the Federation without any trouble. According, however, to a report of the Executive Council meeting of the Mechanical Workers' Union, the members of which are the enginemen and craftsmen who have forsaken the Miners' Federation, the new Union is getting on very well in the Maesteg area, despite the tactics of the Miners' Federation, members of which are alleged to have adopted the method of visiting the houses of the craftsmen in their endeavour to get the womenfolk to bring pressure upon their husbands to return to the Federation fold. From all accounts the craftsmen are more determined than ever to remain loyal to the Mechanical Workers' Union, so it may be that in the future further trouble will again be seen in the Maesteg district if all does not go well with the Miners' Federation plans.

Current Business.

There is no branch of the steam coal market which does not display firmness, and it is almost impossible to book supplies for early loading, as collieries have in many cases more orders than they can cope with, as for the moment outputs are still rather below than average. Inquiries are very active for supplies for shipment during the next week or two, and during the past few days prices have steadily advanced, and not only are salesmen hesitating to put a price on coals for fairly early shipment, but they will not commit themselves regarding values for forward delivery. Sized coals are extremely scarce, and, in fact, are practically unobtainable, as there has recently been quite a run on them. Patent fuel is also firmer, as manufacturers have to pay a higher price for their small coals to make the fuel. In the anthracite section the tone is on the easy side, with the exception of nuts, cobbles and beans. Pitwood is also firmer at 34s. to 35s.

Latest News from the Provinces.

WALES AND ADJOINING COUNTIES.

Swansea Metal Exchange.

THE conditions prevailing in the South Wales steel and tin-plate industries show no change. Business is quiet, and tin-plate prices are below the costs of production. The output is now only about half of the normal.

The Spelter Trade.

After being idle for practically two years, the English Crown Spelter Works are making a re-start. The company are giving employment to those who are ready to accept the terms and conditions regarding wages, and sufficient men to man the first two furnaces are ready to resume.

CATALOGUES.

DONOVAN AND CO., 47, Cornwall-street, Birmingham.—Copy of "Safuse" and "Donlok" gear list.

AITCHISON AND CO., Limited, 428, Strand, W.C. 2.—Illustrated pamphlet dealing with barometers.

STAVELEY COAL AND IRON COMPANY, Limited, Chesterfield.—Illustrated monthly stock list of cast iron pipes.

D.C.M. TAP COMPANY, Limited, 177, West Regent-street, Glasgow.—Price list of D.C.M. taps, and patented screw-cutting taps.

H. TINSLEY AND CO., Werndee Hall, South Norwood, S.E. 25, —List No. 16, dealing with optical pyrometer of the disappearing filament type.

E. J. DAVIS AND CO., Great Eastern-road, Stratford, E. 15.—An illustrated leaflet describing the Davis patented magneto and insulated plug tester.

FREDERICK MONTFORD, Fremo Works, Old Cross-street, Birmingham.—Illustrated booklet describing "Fremo" taper pins, which are machine turned.

EDMUNDSON'S ELECTRICITY CORPORATION, Limited, Broad Sanctuary Chambers, S.W. 1.—Publication No. P 66 deals with "Water Power and the Generation of Electricity."

COWPER-COLES MANUFACTURING COMPANY, Sunbury-on-Thames.—Pamphlets dealing with the protection of iron and steel from corrosion by "Sherardising" or dry vapour galvanising.

ELECTRIC LAMP MANUFACTURERS' ASSOCIATION OF GREAT BRITAIN, Limited, Elma House, 25, Bedford-square, W.C. 1. —An illustrated brochure, entitled "Booming the British Electric Lamp Industry."

O. N. BECK, 11, Queen Victoria-street, E.C. 4.—Illustrated leaflet dealing with the "Paragon" boiler-tube loosener. This is a labour and time-saving device, specially intended for users of steam boilers with straight tubes.

MITCHELL CONVEYOR AND TRANSPORTER COMPANY, Limited, Atlantic House, Holborn-viaduct, E.C. 1.—Illustrated brochure on locomotive coaling and ash-handling plants which have been erected for British railway companies.

J. M. HENDERSON AND CO., King's Works, Aberdeen.—Catalogue 54 I.E. is an illustrated general catalogue produced in four languages, dealing with cranes and mechanical handling appliances for which this firm is well known.

BELL'S UNITED ASBESTOS COMPANY, Limited, Southwark-street, S.E. 1.—Illustrated booklet, entitled "Asbestos Electrical Installation." Details are given of the variety of articles manufactured by the firm for electrical purposes.

CRICHTON, THOMPSON AND CO., Limited, 11, Haymarket, S.W. 1.—Illustrated pamphlet dealing with steel barges which the company has for disposal. The firm has adapted several barges as motor or steam coasters, oil carriers, &c.

AGRICULTURAL AND GENERAL ENGINEERS, Limited, Central House, Kingsway, W.C. 2.—Illustrated leaflet concerning the "Blackstone" four-wheeled coupled oil locomotives, which are manufactured by Blackstone and Co., Limited, Stamford.

BARDUFF, Limited, West Lodge Garage, Uxbridge-road, Acton, W. 3.—A copy of the Barduff book of motoring wrinkles and recipes. Much useful information has been embodied in this small book, which is of a convenient size to slip into the pocket.

BRAMPTON BROTHERS, Limited, Oliver-street, Birmingham. —Illustrated book, entitled "Power Transmission by Chain." The advantages and efficiency of chain gearing are set forth, and much reliable information is given concerning chains and chain wheels.

AABACAS ENGINEERING SUPPLY COMPANY, Limited, 44, Hamilton-square, Birkenhead.—Circular W 117 deals with horizontal, plain, universal and vertical milling machines. The different types are illustrated, as also are the different attachments and accessories.

EWART AND SON, Limited, 346, 348 and 350, Euston-road, N.W. 1.—Illustrated pamphlet, entitled "Hot Water." The "Califont," described in the pamphlet, is maintained by Messrs. Ewart to be the last word in efficiency, comfort, safety and economy, as applied to domestic and public hot water supply.

AUTOMATIC AND ELECTRIC FURNACES, Limited, 281-283, Gray's Inn-road, W.C. 1.—Illustrated catalogue descriptive of the Wild-Barfield patent electric furnaces for the automatic hardening of carbon steel. Besides a general description, much technical detail has been embodied in the catalogue, and each section is illustrated.

LEOPOLD WARD, The Laboratory, Harmood-place, Chalk Farm, N.W. 1.—Small booklet, entitled "Some Notes on Experimental and Research Engineering." Illustrations are given of the different machinery made by Mr. Ward at his laboratory, in his capacity as an "experimental consulting engineer," in developing ideas.

MELDRUMS, Limited, Timperley, Manchester.—Illustrated list dealing with the Meldrum trailer. These trailers are intended for castings, as much as 14 cwt. being carried at a time. They may also be used for conveyance of guns and dogs for shooting parties. An illustrated pamphlet dealing with the "Sack" steam disinfector. An illustrated description of this apparatus appeared in THE ENGINEER for March 25th, 1921.

CHARLES CHURCHILL AND CO., Limited, 9-15, Leonard-street, E.C. 2.—A new edition of the Norton grinding wheel catalogue. This edition has been entirely revised and much useful technical information included, thereby enhancing its use as a catalogue. Also a pamphlet, entitled "The Carson Precision Bench Lathe." Illustrations are given which show in a clear manner the addition to the lathe as it previously existed of the screw-cutting and chasing attachments, which make it suitable for tool-room work and light manufacturing.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	37/-
(1) Spanish	28/-
(1) N. African	28/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	28/- to 26/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	5 7 6	—
No. 1 Foundry	5 5 0	—
No. 3 ,,	5 0 0	—
N.E. COAST—		
Hematite Mixed Nos.	4 17 6	4 17 6
No. 1	4 18 6	4 18 6
Cleveland—		
No. 1	4 15 0	4 15 0
Silicious Iron	4 15 0	4 15 0
No. 3 G.M.B.	4 10 0	4 10 0
No. 4 Foundry	4 7 6	4 7 6
No. 4 Forge	4 2 6	4 2 6
Mottled	3 15 0	3 15 0
White	3 15 0	3 15 0
MIDLANDS.		
Staffs.—		
All-mine (Cold Blast)	11 10 0	—
Part Mine Forge	*None offering.*	
North Staffs. Foundry (*Nom.*)	4 10 0 to 4 15 0	
(3) Northampton—		
Foundry Nos. 2 and 1	*Nominal.*	
,, No. 3	4 2 6 to 4 5 0	
,, Forge	3 15 0	—
(3) Derbyshire—		
No. 3 Foundry	4 5 0	—
Forge	3 17 6	—
(3) Lincolnshire—		
Basic	4 0 0 to 4 5 0	
Foundry	4 5 0 to 4 10 0	
Forge	4 2 6 to 4 5 0	
(4) N.W. COAST—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	5 15 0	—

MANUFACTURED IRON.

	Home. £ s. d.	Export £ s. d.
SCOTLAND—		
Crown Bars	11 10 0	—
Best ,,	12 0 0	—
N.E. COAST—		
Common Bars	12 0 0	—
Marked ,,	17 10 0	—
Tees	14 10 0	—
LANCS.—		
Crown Bars	12 0 0	—
Hoops	14 0 0	13 15 0
S. YORKS.—		
Crown Bars	12 0 0	—
Best ,,	13 0 0	—
Hoops	14 0 0	—
MIDLANDS—		
Marked Bars (Staffs.)	14 10 0	—
Crown Bars	12 0 0 to 13 0 0	
Nut and Bolt Bars	11 0 0 to 11 10 0	
Gas Tube Strip	12 10 0	—
Hoops (*Nom.*)	15 0 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	14 0 0	—
Ship Plates ¾in. and up	10 10 0	—
Sections	10 0 0	—
Steel Sheets ⅛in. to ¾in.	11 15 0	—
Sheets (Gal. Cor. 24 B.G.)	—	16 0 0

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	10 10 0	—
Angles	10 0 0	—
Boiler Plates	16 0 0	—
Joists	10 10 0	—
Heavy Rails	9 10 0	—
Fish-plates	14 10 0	—
Channels	14 10 0	—
Hard Billets	9 5 0	—
Soft Billets	7 5 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	9 10 0	—
Light ,,	11 0 0 to 13 0 0	
Billets	9 5 0	—
Ship Plates	10 10 0	—
Boiler ,,	14 10 0	—
MANCHESTER (*Prices irregular and uncertain, unchanged*)—		
Bars (Round)	10 0 0 to 12 0 0	
,, (others)	11 0 0 to 12 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	12 5 0	12 0 0
Plates	£10 to 12	10 0 0
,, (Lancs. Boiler)	16 0 0	—
SHEFFIELD—		
Siemens Acid Billets	10 0 0 to 11 0 0	
Bessemer Billets	12 10 0	—
Hard Basic	9 5 0	—
Soft ,,	7 10 0 to 8 10 0	
Hoops	12 5 0	—
Soft Wire Rods	11 0 0	—
MIDLANDS—		
Small Rolled Bars	9 15 0 to 10 0 0	
Bessemer Billets	7 10 0 to 8 0 0	
Hoops	12 0 0 to 12 10 0	
Gas Tube Strip	10 10 0	—
Sheets (24 W.G.)	14 0 0 to 15 0 0	
Galv. Sheets (f.o.b. L'pool)	16 0 0 to 16 10 0	
Angles	10 0 0	—
Joists	10 10 0	—
Tees	11 0 0	—
Bridge and Tank Plates	10 10 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/6 to 19/-
Block Tin (cash)	140 0 0
,, (three months)	141 17 6
Copper (cash)	58 0 0
,, (three months)	59 0 0
Spanish Lead (cash)	19 10 0
,, (three months)	19 10 0
Spelter (cash)	24 0 0
,, (three months)	24 7 6
MANCHESTER—	
Copper, Best Selected Ingots	62 10 0
,, Electrolytic	64 10 0
,, Strong Sheets	92 0 0
,, Loco Tubes	0 1 2
Brass Loco Tubes	0 1 0
,, Condenser	0 1 3
Lead, English	21 15 0
,, Foreign	20 0 0

(*Metal prices practically unchanged*).

FERRO ALLOYS,

(*All prices now nominal*).

	Per Ton.	Per Unit
Tungsten Metal Powder	1/8 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£27	10/-
,, 6 p.c. to 8 p.c. ,,	£26 10 0	9/-
,, 8 p.c. to 10 p.c. ,,	£25 10 0	8/-
,, Specially Refined		
Max. 2 p.c. carbon	£70	26/-
,, 1 p.c. ,,	£88	31/-
,, 0·75 p.c. carbon	£103	37/-
,, carbon free	2/- per lb.	
Metallic Chromium	5/3 per lb.	
Ferro Manganese	(per ton) £15 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£13 0 0 scale 5/- per unit	
,, ,, 75 p.c.	£25 10 0 scale 6/- per unit	
,, Vanadium	20/- per lb.	
,, Molybdenum	7/- per lb.	
,, Titanium (carbon free)	1/3 per lb.	
Nickel (per ton)	£180	
Cobalt	14/- per lb.	
Aluminium (per ton)	£110 to £120 (British Official).	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	22/-
,, ,, Ell	22/-
,, ,, Splint	23/6 to 25/6
,, ,, Trebles	24/9
,, ,, Doubles	22/6
,, ,, Singles	18/9
AYRSHIRE—	
(f.o.b. Ports)—Steam	22/-
,, ,, Splint	23/6
,, ,, Trebles	24/9
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	20/- to 23/-
Screened Navigation	28/-
Trebles	25/6
Doubles	22/-
Singles	18/6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	22/9
Secondary Steam	22/-
Trebles	25/6
Doubles	22/6
Singles	18/6

ENGLAND.

(8) N.W. COAST—	
Steams	33/-
Household	40/- to 55/-
Coke	32/-
NORTHUMBERLAND—	
Best Steams	24/- to 26/-
Second Steams	22/- to 23/-
Steam Smalls	14/- to 15/-
Unscreened	21/6
Household	25/- to 30/-
DURHAM—	
Best Gas	22/- to 23/-
Second	20/6 to 21/6
Household	25/- to 30/-
Foundry Coke	38/- to 40/-

SHEFFIELD—	Inland.
S. Yorks. Best Steam Hards	23/- to 25/- —
Derbyshire Hards	22/- to 23/- —
Seconds	22/- to 22/6 —
Cobbles	22/- to 22/6 —
Nuts	18/- to 19/- —
Washed Smalls	12/- to 15/- —
Best Hard Slacks	13/- to 14/- —
Seconds ,,	10/- to 11/- —
Soft Nutty ,,	9/- to 10/- —
Pea ,,	7/- to 8/- —
Small ,,	5/- to 6/- —
House, Branch	37/- to 39/- —
,, Best Silkstone	34/- to 36/- —
Blast Furnace Coke (Inland and Export)	17/6 to 25/-

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	26/6 to 27/-
Second ,, ,,	25/6 to 26/-
Best Dry Large	26/- to 26/6
Ordinary Dry Large	25/6 to 26/-
Best Black Vein Large	24/6 to 25/-
Western Valley ,,	24/- to 24/6
Best Eastern Valley Large	24/- to 24/6
Ordinary ,, ,,	23/- to 24/-
Best Steam Smalls	19/6 to 20/6
Ordinary ,,	15/- to 19/-
Washed Nuts	27/6 to 32/6
No. 3 Rhondda Large	27/6 to 30/-
,, ,, Smalls	20/- to 21/-
No. 2 ,, Large	23/- to 23/6
,, ,, Through	20/- to 21/-
,, ,, Smalls	15/6 to 16/6
Coke (export)	32/6 to 35/-
Patent Fuel	24/- to 27/-
Pitwood (ex ship)	34/- to 35/-
SWANSEA—	
Anthracite Coals:	
Best Large	40/- to 42/6
Seconds	30/- to 35/-
Red Vein	32/6 to 35/-
Big Vein	40/- to 42/6
Machine-made Cobbles	60/- to 65/-
Nuts	65/- to 67/6
Beans	47/6 to 50/-
Peas	20/- to 22/6
Breaker Duff	8/- to 9/-
Rubbly Culm	12/6 to 13/-
Steam Coals:	
Large	22/6 to 25/-
Seconds	20/- to 22/6
Smalls	12/6 to 15/-
Cargo Through	18/6 to 20/-

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—F.O.R. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

French Engineering Notes.

(From our Correspondent in Paris.)

Trade Fluctuations.

THE most unsatisfactory feature at the moment is the sensitiveness of industry to outside influences. All the elements of a trade recovery exist except credit, and credit is in an anæmic stage when it is liable to the ups and downs of a patient on the verge of a collapse. Carefully tended, it might recover slowly and by degrees, and confidence would be maintained sufficiently to permit of business being done; but when the tottering credit is manipulated by a class of speculators who have been plunging the market into a state of depression, the hope of seeing an early return of confidence appears very small indeed. It is probable that the financial situation has become worse and that many manufacturing firms, which have been struggling along in the expectation of better times, can see no way out of the difficulty; but the general state of things is certainly not so bad as is represented by the apparently organised attack on credit, whereby at times public fear for the safety of their deposits in financial institutions has verged on panic. The Government is doing its best to put a stop to these manœuvres, and to a certain extent it has succeeded, but the feeling of nervousness still exists more or less, and is necessarily affecting business everywhere. In the absence of credit the situation of the engineering trades is becoming precarious, and very few orders are being given out, although manufacturers would willingly accept them at a sacrifice. The only encouraging feature is that there is a vast amount of work which must be done at some time or another, and as soon as credit is restored an active recovery may be looked forward to in all branches of trade. Meanwhile, the leading firms are competing keenly for foreign business, sometimes with success, and the Schneider group, which is working with Austrian and other firms in which it is largely interested, has secured some important contracts for harbour and other undertakings. The colonial development is also creating a certain demand for railway, bridge work and other material.

Industrial Organisation.

An interesting development of the past three years has been the organisation of the productive community not only of each branch but also of all the associations representing the different branches of an industry, and these federations of syndicates or associations are exercising an increasingly powerful influence upon matters affecting the industrial progress of the country. In all questions relating to foreign commercial relations, import duties and the like, the federations are consulted by the Government, and meetings are held from time to time to discuss the situation and submit recommendations to the State departments. At a recent meeting of the Federation of the mechanical, electrical and metallurgical industries a series of resolutions was adopted, one of which, affecting the reconstitution of the devastated regions, affirmed the conviction that there is plenty of money in the country, but that the public hesitates to invest it in industrial enterprises. The forthcoming revision of the coefficients was examined, and the Federation declared that it was absolutely essential to industry to bring down productive costs as much as possible, and that the Government must therefore do what is necessary, in arranging the new coefficients, to ensure the supply of cheap raw material. Various reports were presented upon commercial arrangements, the export trade, transport and other matters. Another important organisation is the Union des Sociétés Industrielles, of which a congress is to be held at Rouen in June next to discuss a particularly heavy programme covering fuels, electricity, water purification, metal alloys, standardisation, the employment of machinery, chemical questions, questions affecting the textile industry, social economy, colonial development, &c. The arrangements for the congress are being carried out by the Société Industrielle de Rouen, 2, Rue Ampère, Rouen.

The Railway Council.

By the promulgation of the law providing for the creation of a Superior Council and a technical and commercial Committee the reorganisation of the railway companies under a central control is now being put into effect. The Superior Council will exercise an administrative control over all the railways, although each of the companies will maintain its executive power, and the object of the central body is to ensure as much uniformity as possible in the working and equipment of the railways and to see that the services are carried out in the best interests of everyone concerned. For that reason the Superior Council will consist of representatives of most of the different categories of users. There will be eighteen members of a managing Committee, presumably chosen by the railway companies, two representatives of the railwaymen for each of the principal railway companies, who will be elected for three years, and thirty representatives of the "national interest," these latter including members of the various Government departments, eight representing Chambers of Commerce, the export trade and colonial interests, a representative each of the mining, metallurgical and electrical industries and the construction of railway material, as well of the local railways, four representatives of agricultural associations, three of navigation, and four members of the touring and other associations representing the travelling public. The Committee is intended to investigate and report upon all technical and commercial questions which will have to be dealt with by the Superior Council.

The Collieries.

The work of unwatering and re-conditioning the collieries in the Nord and Pas de Calais is being steadily proceeded with, and it is expected that during the present year they will all be in partial operation again. The surface installations are practically reinstated, and close upon 50 million cubic metres—say 11,000 million gallons—of water have been raised, releasing most of the upper galleries which are being consolidated and prepared for working. Of the 3000 kiloms.—1864 miles—of galleries more than two-thirds were deliberately flooded by the Germans, and owing to the dangerous character of the work of re-conditioning, progress is relatively slow, though satisfactory under the circumstances.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

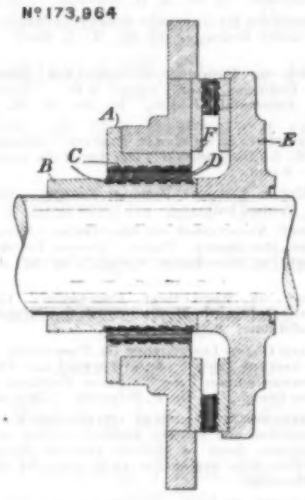
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM TURBINES.

173,964. December 21st, 1920.—IMPROVEMENTS IN AND RELATING TO FLUID PACKING DEVICES, The Honourable Richard Clere Parsons, of 39, Victoria-street, Westminster.

THE clearances in the neck rings, balance discs, and other fluid-obstructing devices of centrifugal pumps, turbines, &c., tend to increase and to cause a corresponding increase in the leakage. The object of this invention is to provide means which will enable small clearances to be maintained. The drawing shows the packing applied to a neck ring A. The neck ring and the sleeve or liner B on the impeller shaft are constructed so as to

Nº 173,964



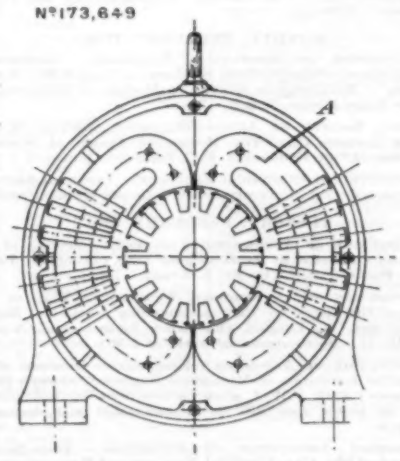
be rigid and are provided with dovetailed recesses to facilitate the attachment of hard rubber or vulcanite C to each metal surface. Tough rubber D, in one or more layers, is superimposed on and vulcanised to the vulcanite as to make up the required thickness. The two soft rubber members are then machined so as to be of accurate finished dimensions and with smooth surfaces. A similar form of packing is shown between the balance disc E and a stationary part F of the pump.—*January 19th, 1922.*

DYNAMOS AND MOTORS.

173,649. October 25th, 1920.—IMPROVEMENTS IN THE MAGNETIC CIRCUITS OF ELECTRIC MOTORS AND DYNAMOS, Henry Robinson, of 8, Rue Lambrechts, Hoboken, Antwerp.

The object of this invention is to avoid the use of cast iron or cast steel in the field frames of direct-current machines, and also to reduce labour and material. It will be seen from the drawing that C-shaped sheet iron sectors A formed of sheet iron

Nº 173,649



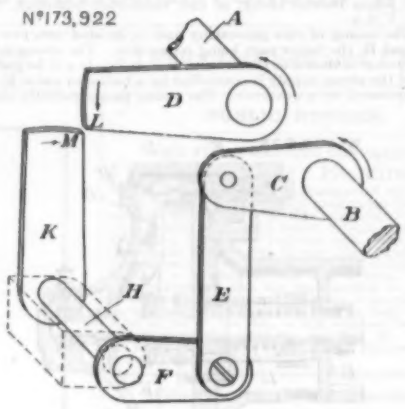
stampings and assembled and riveted together are used instead of the usual cast poles. These sectors are shaped so as to form a complete magnetic circuit as far as the field portion is concerned, and there is no interruption in the magnetic circuit at any point except at the space between the poles and the armature.—*January 12th, 1922.*

SWITCHGEAR.

173,922. October 29th, 1920.—IMPROVED MEANS FOR INTERLOCKING ELECTRIC SWITCHES, Adolph Harry Railing, Charles Cornfield Garrard, and William Wilson, all of 67, Queen Victoria-street, E.C.

The device described in this specification is applicable mainly to contactors, but it may also be applied to other switches. Its object is to ensure a certain and definite interlock between the contactors or switches without the use of elaborate mechanism. In the drawing A and B are two contactor or switch axles placed in the same straight line. A lever C is attached to the shaft B and a lever D to the shaft A, the latter being considerably longer than the former. To the shorter lever C an insulating link E is pivoted, and at its lower end another lever F is provided and is fixed to a horizontal shaft H. At the other end of this shaft is a vertical lever K. If the shaft A rotates in the direction indicated by the arrow, the corner L of the lever D takes a lower position and effectively prevents the lever K from turning to the right, and this prevents the shaft B from turning. On the other hand, if shaft B revolves by even the slightest amount in the direction required to close the contactor, the corner M of the lever K will

Nº 173,922



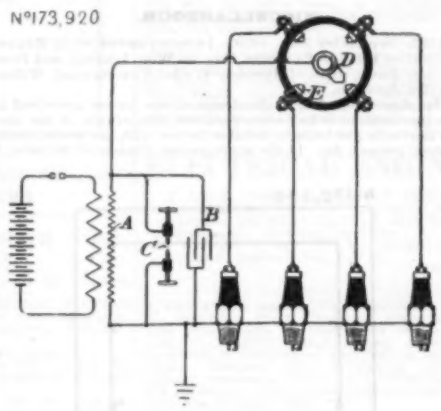
move to the right, and on passing under the corner L of the lever D prevents lever D from moving downwards. Thus, whichever shaft is first moved, even slightly, in the direction to close a contact, the other shaft is effectively locked against motion.—*January 19th, 1922.*

ELECTRIC IGNITION.

173,920. October 27th, 1920.—IGNITION SYSTEMS, Herman William Eichbaum, of Los Angeles, California.

The various parts of this ignition system are shown in the diagram and are self-explanatory. The principle of operation is as follows:—The potential induced in the secondary A charges the condenser B. The gap C is set so that before this potential reaches the higher value which it would attain if the gap were not present, the air in the gap breaks down and the condenser therefore discharges. An oscillating discharge is set up, and this first occurs at the gap C. As the gap between the moving contact D and the fixed contact E diminishes, the existence of this variable spark gap plus the gap between the sparking points

Nº 173,920



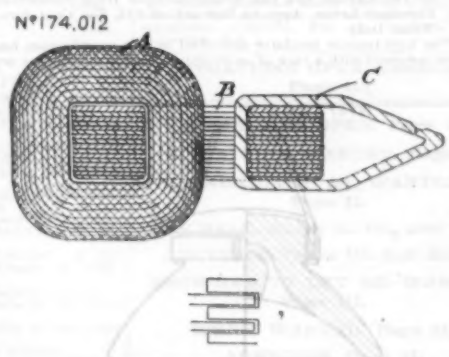
also diminishes until it is approximately the same as that of the gap C. Wherever this occurs an oscillating discharge takes place between the contacts D and E and between the points of the sparking plug connected to those contacts, and as the contact D closely approaches the contact E the oscillating discharge at the gap C will entirely stop. This process is repeated as the moving contact D moves in front of the remaining fixed contact. High-frequency sparks occur at the points of the various plugs in the proper sequence, and, as is well known, in the event of a spark plug becoming fouled or the insulation becoming defective, the oscillating discharge will jump at the points of the plug in preference to passing through the carbon and oil or other foreign material.—*January 19th, 1922.*

MACHINE TOOLS AND SHOP APPLIANCES.

174,012. November 1st, 1920.—IMPROVEMENTS IN SOLDERING IRONS, George Pott and James Roy Laird, both of the Carron Company, Carron, Falkirk, Stirlingshire.

This invention relates to soldering irons in which the bit of the iron forms, when the iron is in operative condition, the secondary

Nº 174,012



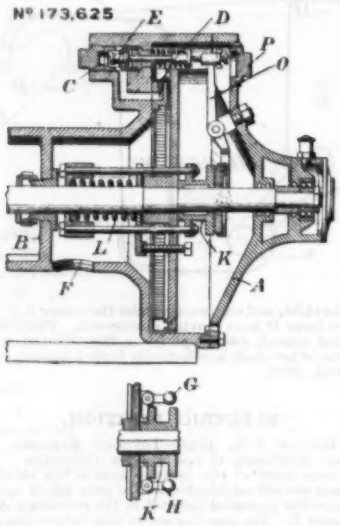
of a transformer, constituting a resistance which is heated by the flow of current through the primary, the primary being constituted by another element of the iron. There is a break or gap in the secondary circuit which is only closed when the solder is placed across the gap, the solder being melted on account of its own resistance. A is the primary winding, B the core, and C the

secondary. The gap is irregular, as shown in the lower illustration, so as to provide a broad surface for reception of the solder.—*January 19th*, 1922.

LOCOMOTIVES.

173,625. October 11th, 1920.—POWER GENERATING UNITS FOR LOCOMOTIVE HEADLIGHTS, Henry Exall Elrod and Benjamin Burton Lacey, of 220, Interurban-buildings, Texas, U.S.A.

The casing of this generating unit is divided into two parts A and B, the latter part being removable. The steam inlet to the rotor is shown at C and the nozzle at D. It will be gathered that the steam supply is controlled by a balanced valve E which is operated by a governor. The steam passes radially through

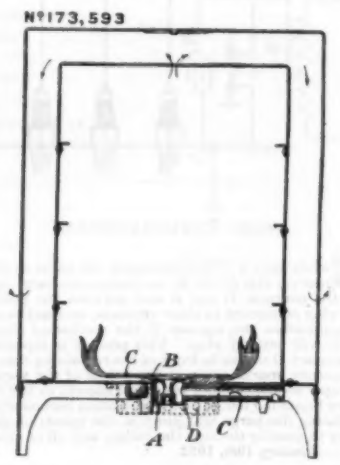


the rotor and out of the turbine by way of the exhaust F. As the shaft revolves, the weights G H move the collar K outwards against the action of the spring L, and the valve E is operated through the medium of the lever O. The governor can be adjusted by removing the plug P.—*January 11th*, 1922.

MISCELLANEOUS.

173,593. September 30th, 1920.—IMPROVEMENTS IN OR RELATING TO BUNSEN BURNERS, Bowden Wire, Limited, and Preston Davis, both of Bowden Works, Victoria-road, Willesden Junction.

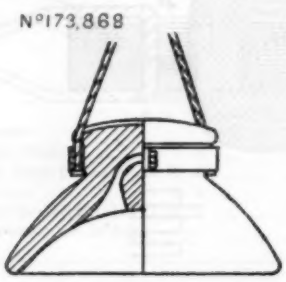
The object aimed at in the design of the burner described in this specification is to secure complete combustion of the gas. The burner is particularly suitable for use with gas ovens, range heaters, geysers, &c. In the arrangement illustrated the tube A



is provided with one or more circular slots B through which the gas and primary air pass. Baffle plates C cause the flame to be spread or thinned out into a film which enables the atmospheric or secondary air to enter the flame. The area of the slots B can be adjusted. C is the mixing tube and the holes through which the secondary air passes are shown at D.—*December 30th*, 1921.

173,868. October 8th, 1920.—IMPROVEMENTS IN OR RELATING TO INSULATORS FOR THE SUSPENSION OF HIGH-POTENTIAL ELECTRIC LINES, Augusto Richard, of 115, San Cristoforo, Milan, Italy.

The high-tension insulator described in this specification has been designed with a view of overcoming the difficulties that are



often experienced with insulators of this type, such as instability, deterioration and inflation of the cement and similar materials employed to bind the metal parts with the insulating element. The improved insulator has but one interior channel, whilst the function of the other channel is fulfilled by grooves provided in the outer part of the insulator. The connection between the various elements is effected by means of cords, braids, or metal bands, more or less flexible, extending from the interior part of one element to the exterior part of the successive element. This arrangement makes it possible to have much greater spaces between the metal parts and consequently to have a greater amount of insulating material between them.—*January 9th*, 1922.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

JUNIOR INSTITUTION OF ENGINEERS.—Caxton Hall, S.W. Lecture, "Curved Beams, Rings and Chain Links," by Professor E. G. Coker. 8 p.m.

THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN: MERSEYSIDE BRANCH.—The Walker Engineering Building, The University, Liverpool. Lecture, "The Printing Telegraph," by Mr. H. H. Harrison. 7.30 p.m.

WEST BROMWICH ENGINEERING SOCIETY.—Technical School. "Ball and Roller Bearings," by Mr. W. A. Ecob. (Lantern.) 7.30 p.m.

INSTITUTION OF PRODUCTION ENGINEERS.—Institution of Mechanical Engineers, Storey's-gate, S.W. "Intensive Production of Automobile Bodies," by Mr. G. W. Eastwood. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Discourse on "The Age of the Earth," by Dr. John Jolly. 9 p.m.

ROYAL METAL TRADES' PENSION SOCIETY.—Grand Hall, Hotel Cecil. Annual ball.

MANCHESTER ASSOCIATION OF ENGINEERS.—Memorial Hall, Albert-square, Manchester. Paper, "Recent Developments in the Treatment of Manchester Sewage," by Dr. E. Ardern. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS: GRADUATES ASSOCIATION.—Connaught Rooms, Great Queen-street, Kingsway. Annual dinner. 6.45 for 7.15 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Lecture Theatre of the Literary and Philosophical Society, Newcastle-upon-Tyne. "Some Problems of Marine Diesel Engine Design," by Mr. P. Belyavin. 7.30 p.m.

THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Joint Metropolitan and Eastern District meeting at Romford. London members meet at Holborn Council offices (opposite British Museum Tube Station) at 10.30 a.m., for motor coach journey to Romford.

ROYAL SOCIETY OF ARTS: DOMINIONS AND COLONIES AND INDIAN SECTIONS.—John-street, Adelphi, W.C. 2. Paper, "Brown Coals and Lignites: Their Importance to the Empire," by Professor W. A. Bone. 4.30 p.m.

TECHNICAL INSPECTION ASSOCIATION.—Royal Society of Arts, John-street, Adelphi. Lecture, "The Extrusion of Metals," by Mr. R. Genders. 7.30 p.m.

SATURDAY, FEBRUARY 25TH.

JUNIOR INSTITUTION OF ENGINEERS: NORTH-EASTERN SECTION.—Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. "Drop Stamping and General Forge Work," by Messrs. E. F. Lough and R. N. Richardson. 7 p.m.

ASSOCIATION OF ENGINEERS-IN-CHARGE.—St. Bride's Institute, Bride-lane, Fleet-street, E.C. 4. Informal discussion on "Mechanical Stokers *v.* Hand Firing, both with Forced Draught." 7.30 p.m.

ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN: MERSEYSIDE BRANCH.—University, Engineering Building, Liverpool. "The Printing Telegraph," by Mr. H. H. Harrison. 7.30 p.m.

MONDAY, FEBRUARY 27TH.

INSTITUTION OF MECHANICAL ENGINEERS: GRADUATES ASSOCIATION.—Storey's Gate, St. James's Park, S.W. Special lecture. "Metallurgy in relation to Mechanical Engineering," by Sir Henry Fowler, K.B.E. 7 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. Cantor Lecture II., "The Mechanical Design of Scientific Instruments," by Professor A. F. C. Pollard. 8 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: INFORMAL SECTION.—Engineers' Club, Coventry-street. Annual smoking concert.

TUESDAY, FEBRUARY 28TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Meeting of the Coventry Graduates at the Broadgate Café, Coventry. Paper, "The Fuel Question." by Mr. J. Newey. 7.45 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Visit of the London Graduates to the coachbuilding works of Messrs. Barker and Co., Limited, Olaf-street, Latimer-road, Notting Hill, W. 11. Meet outside the works at 2.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Informal meeting at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W. 1, when various recording instruments used on motor cars will be demonstrated and discussed. 7.30 p.m.

KEIGHLEY ASSOCIATION OF ENGINEERS.—Through the courtesy of the City Electrical Engineer and Manager, a visit has been arranged to the Valley-road works of the Bradford Corporation electricity department. Train leaves Keighley 5.57 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—Grosvenor Restaurant, Glasgow. Dinner.

INSTITUTE OF MARINE ENGINEERS.—The Minories, Tower Hill, E. 1. "Combined Internal Combustion and Compressed Air Engine," by Mr. R. W. Robinson. 6.30 p.m.

ILLUMINATING ENGINEERING SOCIETY.—Royal Society of Arts, John-street, Adelphi. Discussion on "Industrial Lighting: Ideal Requirements (Legislative and Otherwise) and Practical Solutions," to be opened by Mr. L. Gaster. 8 p.m.

WEDNESDAY, MARCH 1ST.

THE NEWCOMEN SOCIETY.—Caxton Hall, S.W. "Timothy Hackworth and the Locomotive," by Mr. Robert Young. 5 p.m.

NORTHAMPTON ENGINEERING COLLEGE ENGINEERING SOCIETY.—St. John-street, Clerkenwell, E.C. 1. Paper, "Photo Elasticity for Engineers," by Professor E. G. Coker. 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: WIRELESS SECTION.—Victoria Embankment, W.C. 2. "The Thermionic Triode and Rectifier," by Messrs. E. B. Moullin and L. B. Turner. 6 p.m.

INDUSTRIAL LEAGUE AND COUNCIL.—Caxton Hall, S.W. "The Purpose of Economic Activities," by Mr. Hilderic Cousens. 7.30 p.m.

THURSDAY, MARCH 2ND.

INSTITUTION OF ELECTRICAL ENGINEERS.—Victoria Embankment, W.C. 2. Discussion on "Starters," with introductory papers by Messrs. C. H. Wordingham, J. Anderson and W. Wilson. 6 p.m.

ROYAL AERONAUTICAL SOCIETY.—Royal Society of Arts, John-street, Adelphi, W.C. 2. "Testing Aircraft to Destruction," by Mr. W. D. Douglas. 5.30 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—Chemical Lecture Theatre, Municipal College of Technology. Sackville-street, Manchester. Lecture, "Coal Gas: Mainly Carbonising," by Mr. W. Buckley. 7 p.m.

FRIDAY, MARCH 3RD.

BRITISH NON-FERROUS METALS RESEARCH ASSOCIATION.—Queen's Hotel, Birmingham. Annual meeting. 12.50 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—Caxton Hall, S.W. Lecturette, "Factory Administration," by Mr. E. T. Elbourne. 8 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, S.W. 1. Informal meeting. "Spiral Bevel *v.* Straight-tooth Bevel," by Mr. A. P. Bale. 7 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Discourse, "Microscopic Parasites and their Carriers," by Mr. C. Morley Wenyon. 9 p.m.

SATURDAY, MARCH 4TH.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—Caxton Hall, S.W. 1. "Lubrication of the Modern Locomotive," by Mr. J. Clayton. 2.15 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Lecture I., "Radioactivity," by Sir Ernest Rutherford. 3 p.m.

MONDAY, MARCH 6TH.

BRADFORD ENGINEERING SOCIETY.—Bradford Technical College. "The Magneto," by Mr. S. J. Young. 7.30 p.m.

WEDNESDAY, MARCH 8TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Institution of Mechanical Engineers. Paper, "The Design and Function of Laminated Automobile Suspension Springs," by Mr. A. A. Remington. 8 p.m.

WEDNESDAY AND THURSDAY, MARCH 8TH AND 9TH.

INSTITUTE OF METALS.—Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. Annual general meeting. 10 a.m. Annual dinner, March 8th, at Trocadero Restaurant, Piccadilly-circus, W. 1. 8 p.m.

THURSDAY, MARCH 9TH.

FARADAY SOCIETY AND THE OIL AND COLOUR CHEMISTS ASSOCIATION.—Joint meeting at Chemical Society, Burlington House, W. 1. Papers on "The Properties of Powders," by Messrs. L. C. McHatton, C. A. Klein, W. J. Palmer, and R. W. Whymper; Dr. J. W. French and R. S. Morrell; Professor T. Martin Lowry and P. G. S. Boswell. 8 p.m.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—Sir John Cass Technical Institute. Jewry-street, Aldgate, E.C. 3. "Microstructure and Physical Properties of Alloys," by Dr. D. Hanson. 8 p.m.

FRIDAY, MARCH 10TH.

JUNIOR INSTITUTION OF ENGINEERS.—Caxton Hall, S.W. 1. Paper, "Friction," by Mr. C. Hubert Plant. 8 p.m.

FRIDAY, MARCH 17TH.

FARADAY HOUSE OLD STUDENTS' ASSOCIATION.—Queen's Hotel, Leicester-square, W.C. 2. Smoking concert. 8 p.m.

WEDNESDAY, MAY 3RD.

INSTITUTE OF METALS.—Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. Annual May lecture: "The Relation of the Elements," by Sir Ernest Rutherford. 8 p.m.

THURSDAY AND FRIDAY, MAY 4TH AND 5TH.

IRON AND STEEL INSTITUTE.—Institution of Civil Engineers, Great George-street, S.W. 1. Annual meeting. Annual dinner, Thursday, May 4th, at Connaught Rooms, Great Queen-street, W.C.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

WE are asked to state that the head office of Nobel Industries, Limited, has been moved from 6, Cavendish-square, W. 1, to Nobel House, Buckingham-gate, S.W. 1, and that all business and correspondence is now being conducted from the new headquarters of the company.

MR. S. H. WHITE (late A. T. Walmisley and White), of 9, Victoria-street, S.W., has taken into partnership his son, Mr. L. A. White. The business will be carried on under the style of S. H. White and Son.

MR. ARTHUR R. ASHMORE, of 4, Station-parade, Balham High-road, London, S.W. 12, asks us to state that his telephone address has been changed from Battersea 1891 to Streatham 2386.

THE HELICAL BAR AND ENGINEERING COMPANY, of 72–74, Victoria-street, London, S.W. 1, informs us that it has recently been appointed sole selling agent in this country for Le Matériel Roulant, Constructions, Forges et Fonderies de Fourchambault of Paris.

THE KITSON-EMPIRE LIGHTING COMPANY, Limited, of Stamford, Lincolnshire, inform us that, with the authorisation of the Board of Trade, it is changing the name from the Kitson-Empire Lighting Company, Limited, to that of the Kitson Engineering Company (London), Limited, and that it has opened London offices with showrooms at No. 1, Central Buildings, Westminster, S.W.1.

WILKES, Limited, Grand Junction Works, Darlaston, Staffs, has appointed Messrs. John Cawley and Co., of 53, Victoria-street, Westminster, London, S.W. 1, as its London representatives.

CONTRACTS.—Messrs. P. C. Richardson and Co., chimney builders, of 152, Victoria-road, Middlesbrough, have just received a contract from Courtaulds, Limited, Flint, North Wales, to erect and provide all materials for what is believed to be the largest and the tallest chimney stack—in fact, the tallest building of any kind in Wales. The chimney will rise to a height of 300ft. above ground level, the internal diameter at the top will be 16.t., the foundations will penetrate to a depth of 21ft. 6in., total height 321ft. 6in. The shaft has been designed to withstand a wind pressure of 100 miles per hour.